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EFFECTIVENESS OF THE ARMY TECHNICAL DATA PACKAGE IN TECHNOLOGY TRANSFER FOR PROCUREMENT

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THE EFFECTIVENESS OF THE ARMY TECHNICAL DATA PACKAGE IN TECHNOLOGY TRANSFER FOR PROCUREMENT

National Materials Advisory Board
(NAS-NAE)

Prepared for:

Army Materiel Command
Frankford Arsenal

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A study was conducted to assess the adequacy and effectiveness of the Army's use of the Technical Data Package (TDP) in the transfer of technology from a developer to a new contractor for volume production. A selected TDP from each of five of the Army Commands was examined; four were considered effective, the fifth was considered inadequate. The Committee finds that the Army has used the TDP effectively in procurement but the small percentage of difficulties represents a significant sum

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Item 20. (Abstract) continued:

in volume procurement. Nine categories of problem areas were identified and alternative procedures are suggested.

THE EFFECTIVENESS OF THE ARMY TECHNICAL DATA PACKAGE IN TECHNOLOGY TRANSFER FOR PROCUREMENT

REPORT OF THE
COMMITTEE ON TECHNOLOGY TRANSFER
VIA THE TECHNICAL DATA PACKAGE

NATIONAL MATERIALS ADVISORY BOARD
Commission on Sociotechnical Systems
National Research Council

Publication NMAB-325
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NOTICE

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the Committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

This study by the National Materials Advisory Board was conducted under Contract No. DAAA25-74-C0383 with the Department of the Army.

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PREFACE

In conducting its study, the NMAB ad hoc Committee on Technology Transfer via the Technical Data Package has benefited from the advice and counsel of engineers, attorneys and procurement specialists from academe, government, and industry who have had extensive experience in technology transfer for procurement. In addition, selected government agencies that procure comparable items were invited to designate liaison representatives to the committee. Through these people, the committee was able to identify and obtain pertinent reference literature in the form of operating instructions and published articles on procurement practices. Of particular significance were the in-depth assessments of some aspects of their own procurement procedures conducted over the past few years by Army personnel.

Members of the National Materials Advisory Board study groups serve as individuals contributing their personal knowledge and judgments and not as representatives of any organization in which they are employed or with which they may be associated.

The quantitative data published in this report were intended only to illustrate the scope and substance of information considered in the study and should not be used for any other purposes, such as in specifications or in design, unless so stated.

The committee wishes to express its appreciation to the people listed herein and numerous others not identified who have contributed to the completion of this study. In addition to the members, liaison representatives and designated Command contacts, a number of people made substantial contributions to this report. Some of these were professional colleagues of the committee participants who served unofficially, lending their ideas, advice and assistance to various portions of the work.

The committee is most grateful to the presenters (listed in Appendix A) in the January 7-9, 1975 orientation presentation and Service representatives who participated in subsequent discussions. Their competence and enthusiasm have had a lasting impact on the committee. They provided an overview of the situation which was essential to the effective performance of the committee.

Others served as technical advisors to the committee and contributed their special technical expertire. Among them, the committee wishes to acknowledge:

Dr. Richard Charles
General Electric Company
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Mr. Donald Robinson
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The committee is indebted to Dr. Edwin A. Gee, E. I. DuPont de Nemours & Co., Inc.; Dr. William R. Prindle, American Optical Corporation; and Dr. Max L. Williams, University of Pittsburgh, members of the National Materials Advisory Board, for their conscientious reviews and constructive critiques of the report. In addition, special appreciation is expressed to the staff members of NMAB. The professional competence and devoted effort of these people contributed significantly to the preparation of our report.

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I

SUMMARY

Technology transfer in this report is limited in meaning to the process of transferring from the developer to the manufacturer the data necessary for the production of an item for the Army. This transfer is usually accomplished by drawings and/or specifications called the Technical Data Package (TDP).

The Army has been studying its procurement procedure in depth and with a high degree of sophistication. As part of this continuing study the National Academy of Sciences was requested to form an ad hoc committee to examine the adequacy and effectiveness of its technology transfer through use of the TDP. The scope of this study involves only those items in which the TDP is used for the first time in the step between development and manufacture by a source other than the developer. This is the step in which most problems are encountered.

In the study the Committee considered the two separate steps: 1) the preparation of the TDP, and 2) the use of the TDP in procurement. The Committee examined five TDPs selected as representative examples by Army Commands and found that four were very good and encountered very few, if any, difficulties in production; the fifth was considered inadequate. The Committee also made a comparison of the Engineering Change Proposals (ECP) associated with three TDPs with those associated with comparable data from an automobile manufacturer. It was found that the distribution and number of changes were comparable.

The important difficulty with any TDP is that it will invariably contain defects until proven by prototyping or by a limited production run. Methods of improving the quality of the drawings were examined but it is recognized that these are limited. A method being used by the Army of assuring the producibility from a TDP is called Preproduction Evaluation (PPE). In this procedure the contractor

examines the drawings for errors before he begins production and adds the cost of this effort to his bid. After PPE he assumes responsibility for defects in the TDP. In contrast, the Navy makes a clearer distinction in the allocation of this risk. The contractor examines the drawings and thereafter is responsible for patent (or should-have-been-obvious) defects, while the Navy remains responsible for latent (not obvious before production) defects.

The Committee finds that the Army has a good record in procuring with TDPs, although with the enormous volume of purchases involved, a small percentage of difficulties represents a significant sum.

In the course of its deliberations, the Committee was made aware of some of the experiences of the Navy and industry in technology transfer for procurement. Selected items which the Army may find useful are discussed in the body of the report.

In addition, nine categories of problem areas were identified, although they are not independent. Alternative procedures to current Army practices are given to assist in TDP improvement or in cost savings in procurement. All of these alternatives are considered possible within the current Armed Services Procurement Regulations.

The problem areas and summaries of possible solutions are listed below:

1. <u>Utilization of Engineers</u>

The Army, with the exception of cases involving procurement of hazardous materiel, does not fully utilize its engineers in the procurement process.

The most striking difference between industry and Army methods is that industry has engineers sharing responsibility with procurement personnel, while the Army often does not. In industry, the engineers who develop the TDPs and know them best advise on selection of the manufacturer, inspect manufacturing procedures and trouble-shoot when necessary. In the Army the procurement personnel, who seldom have engineering capability and are often physically apart

from the engineers, have the responsibility of procuring an item. The Committee suggests that if the Army were to insure closer collaboration between engineering and procurement personnel, many of the problem areas listed below could be alleviated or avoided.

2. Consistency of TDP Quality

The Army Commands have independent procurement functions which lead to variation in procedures. The result is an uneven quality of TDPs. The Army might consider establishing an independent Army product engineering activity which could be of value in performing audits of TDPs, configuration management procedures, pre- and post-award contractor evaluations, surveys, evaluation of claims and disputes, and assurance of reliability, availability and maintainability requirements.

3. Contractor Qualification

The Army Commands sometimes have difficulty in rejecting a low bidder that is not considered qualified. Present procedure involves site visits, trip reports and other documentation, all of which are expensive and on occasion are done without assurance that the recommendations will be supported fully at higher levels. The Commands seem to start with the assumption that the burden of proof of non-qualification rests with them, although ASPR 1-902 clearly states that a "prospective contractor must demonstrate affirmatively his responsibility." Contractor qualifications should be stringently examined and, since procurement personnel must rely on the engineers for non-responsibility determinations, experience requirements and qualifications of manufacturer, it is axiomatic that the engineers' opinion should be backed by higher authority.

4. Buy-Ins and Bail-Outs

At times the low bid is clearly lower than the cost of producing the item; this is called a "buy-in." The contractor, in these circumstances, is motivated to contest every government action related to the procurement, as well as

the adequacy of the TDP. This often results in a significant number of claims which, if paid without contest, are characterized as "bail-outs." The Committee understands that this is a frequent problem. It should not be, since DoD Directive 5000.1 clearly states that a proposal which cost analysis indicates to be a buy-in should be downgraded.

5. Motivation of Design Contractor

Most contractors are interested in the manufacturing phase of an item. Hence, there is little motivation to produce an excellent TDP which will provide technical data to a competing manufacturer. The easiest solution in this case would be to permit the developer to have part of the production, contingent upon his producing a TDP satisfactory for use in production by another manufacturer.

6. Proprietary Information

The developer is entitled to place a proprietary legend on data relating to an item, component or process developed at private expense. The TDP must exclude such limited rights data and substitute "form, fit, or function" data covering the item or process. A TDP containing large amounts of proprietary data may not be adequate for use by another manufacturer and should be screened accordingly from competitive procurement. In dealing with proprietary data, the Army has four choices: i) purchase the proprietary rights, ii) contest the developer's claim, iii) procure the item sole source from the developer, or iv) let a separate development contract to design around the item or process.

7. TDP Defects

Where the Army has retained in-house development capabilities, the TDPs which were examined were of high quality, but it appears that the Army does not exercise the same degree of discipline in the supervision of contractor developed TDPs. Drawings can be improved by a third party review or by Preproduction Evaluation, but the Committee favors a limited production run to demonstrate the completeness of a TDP, as employed by industry. A TDP will not be used for

production procurement by industry until an independent group has used it to build the item. The Committee suggests that the Army give serious consideration to the proof of all TDPs by prototyping or limited production runs.

8. Technology which Cannot Be Transferred by Documents Alone

For many complex items the transfer of technology from the developed prototype to the manufacturing phase cannot be done solely by blueprints or process descriptions. In industry, engineers and technicians are sent to facilitate the transfer. Success of licensing in aircraft co-production led to the Committee suggestion that the development contract might include a provision that a follow-on contractor be taught and assisted in starting successful co-production. This could be paid for by means of a royalty, license fee, or learning contract.

9. Cost-Benefit Analysis

Procedures such as prototyping, limited production, and TDP reviews all add to the cost. The choice of these options can be determined by cost-benefit analysis. While industries and the other Services have such analysis groups available to them, it was learned that the Army Materiel Command and its subordinate Commands do not. The Committee suggests that cost-benefit analysis capability for the selection of optimum procurement strategy be made available to the Commands either within the Army or by contract.

In the Advance Procurement Planning regulation of ASPR it is stated that the decisions on the best method of procurement should be made in the development stage. In addition to the conventional bases of such decisions, the Committee feels that further consideration of the factors discussed above should be used in making competitive procurement decisions.

II

INTRODUCTION

A. Scope

"Technology transfer" is a phrase with multiple usage and hence a variety of meanings. In this report, its meaning is limited to the process of transferring from the developer to the manufacturer the data necessary for the production of an item for Army use. This transfer is usually accomplished by means of a set of drawings and/or specifications called the Technical Data Package (TDP). The TDP will be defined more completely in section IIB.

According to the Advance Procurement Planning (APP) document of the Armed Services Procurement Regulations (ASPR), a decision is to be made early in development of the method of procurement, e.g., sole source, competitive, negotiated and, based on this decision, the need for a TDP is determined. The cost of a TDP is not negligible. It is estimated[1] that each year the Defense Department buys about $2 billion worth of engineering drawings, technical manuals, specifications, etc. The Department of Defense (DoD) recognizes that data are an asset which must be managed with the same degree of attention as hardware and has accordingly issued DoD Instructions 5010.12 and 5010.29 as guides for its acquisition.

The Army purchases many items without a TDP by either issuing "form, fit or function" specifications or by resorting to sole source contracts. It also purchases many items with TDPs which have been used many times for reprocurement and, as a consequence, are highly refined and virtually without error.

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[1] Donald R. Mitchell. "Technical Data Management--Progress and Problems. Defense Management Journal 9(April 1973):30-2.

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The Army has been studying its procurement procedures in depth, with a high degree of sophistication. As part of this continuing study, it has asked the National Academy of Sciences to form an ad hoc committee to examine the adequacy and effectiveness of its technology transfer through the use of the Technical Data Package. The scope of this study involves only those items in which the TDP is used for the first time in the step between development and manufacture by a source other than the developer. This is the step in which most problems are encountered.

The formal charge to the ad hoc committee assigned this study is as follows:

> Conduct an engineering study with the object to evaluate the effectiveness of the U.S. Army Technical Data Package (TDP) in conveying design and manufacturing criteria to prospective materiel producers. The effort will include a detailed evaluation of at least five specific TDPs selected by the sponsor. Recommendations relating to the available options for improving technology transfer will be developed.

Although this scope is narrow in the context of the overall procurement system of the U.S. Army, it is fundamental to the procedures currently in use in competitive procurement.

The Committee addressed itself to the two implied steps in this procedure, i) the creation of the documents, and ii) the method used in conveying them to manufacturers.

B. Army Usage of the TDP in Procurement

The mission requirements for military design equipment begin with advance procurement plans which are then forwarded, with program and budget plans, to the appropriate Army Commands. Following the R&D phase, the end item is to be manufactured. Although there are exceptions, multiple bids are solicited for

many items. It has been amply demonstrated[2,3] that considerable cost savings can result from competitive bidding for the production contract.

The basis for the bid solicitation is the procurement package (PP) which contains the technical data package (TDP). The official definitions of these terms are the following:

1. Technical Data Package (TDP)

A technical description of an item adequate for use in procurement. The description defines the required design configurations and assures adequacy of item performance. It consists of all applicable technical data such as plans, drawings/associated lists, specifications, standards, models, performance requirements, quality assurance provisions, and packaging data. (AMCR 70-46)

2. Procurement Package (PP)

The information required to obtain bids or proposals. It is comprised of the TDP describing the item or service to be procured together with all applicable administrative, legal, and fiscal provisions as are necessary for a clear and complete description of the item desired and the conditions governing the proposed contractural agreement between the government and the supplier. (AR 310-25, AMCR 70-46)

When the drawings of the TDP are prepared under contract by the developer according to military standards (MIL-D-1000 and MIL-STD-100A), Army employees, usually technical personnel assigned to the development phase, check the TDP for completeness and accuracy and approve payment. Since a newly developed

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[2] M. J. Peck, and F. M. Scherer. "The Weapons Acquisition Process: An Economic Analysis." Harvard University Press, 1962.

[3] K. D. Griffiths, and R. F. Williams. "Transmission of Procurement Technical Requirements in the Competitive Reprocurement of Military Design Equipment." PRO-005-1. Army Procurement Research Office, Institute of Logistics Research, Fort Lee, Va., 1971.

item is not necessarily frozen in design, improvements, substitute materials, etc. may be incorporated in approved Engineering Change Proposals (ECP) that are attached to the original TDP and become part of the PP. The procurement package then is transmitted to procurement personnel for bid solicitation.

A single contractor does not necessarily become the producer of the total system purchased. Procurement personnel may separate the package into units or a contractor may subcontract for components. To ensure the participation of small business, a representative of the Small Business Administration (SBA) examines each procurement package for possible "set asides" and "break-outs." If a package will cost less than $1 million to produce, the SBA representative is permitted to set it aside for a small business manufacturer. If a specific part of a package can be clearly identified as a single unit costing less than $1 million to produce, the SBA representative may break it out from the total PP and require that only a small business be permitted to manufacture it. A list of qualified bidders in the geographical area is given by the SBA to the local procurement office.[4] If an Army program manager believes for technical reasons that the procurement of the item may be jeopardized by giving its production to a small business, he may reject the decision. The SBA representative then may appeal to the Commanding Officer. If that appeal is rejected, the SBA may then appeal directly to the Secretary of the Army, who makes the final decision.

In the present organization of the Army, the procurement personnel often are separated from the engineering personnel and do not themselves have engineering capability. Under these circumstances, they simply accept the PP as transmitted. This is called the "rubber band" procedure in that they do not

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[4] Report of the Commission on Government Procurement. vol. 1 (Washington, D. C.: U.S. Government Printing Office) Chap. 12, 1972.

remove the imaginary rubber band from the package of documents and assume it to be acceptable for procurement when they offer it to prospective bidders.

When an agency of the government solicits bids based on a TDP, there is an implied warranty[5-6] that its specifications and drawings are correct. Experience has shown that large quantities of detailed drawings will contain defects and, although extensive reviews can reduce the number of defects, the law of diminishing returns precludes perfection. Thus, the successful bidder, especially in a first production, is nearly always confronted with a TDP with some errors in the drawings or specifications. If he is so motivated, the bidder may file a claim against the Army for increased expense or time that the errors have cost him. If a settlement is not achieved, then the case must be heard by the Armed Services Board of Contract Appeals. With time for necessary legal preparation and the current backlog, such a case takes about two years to be resolved. To help alleviate this rather untenable situation, the Army has introduced a procedure called Preproduction Evaluation (PPE) which permits the successful bidder a specific number of days to examine the TDP for errors before beginning production. The cost of this effort is included in his bid.

The Army must procure a wide range of items and a single rigid procurement policy would be unsuitable. This is recognized, and sufficient flexibility is given in the wording of the Armed Services Procurement Regulations (ASPR) and the Army Materiel Command Regulations (AMCR). Each of the Army commands utilizes this flexibility to suit its particular needs, e.g., while a gun may be specified by its material properties and machining tolerances, a radio may be

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[5] George H. Dygert. "Implied Warranties in Government Contracts." Military Law Review 53(1971):39-72.

[6] Ralph C. Nash, Jr., and John Cibinic, Jr. Federal Procurement Law, 2nd ed. Washington, D.C.: George Washington Law Center, 1969.

better specified functionally with respect to range, band width and noise level. Thus a TDP may give either detailed drawings or performance specifications, and sometimes both.

Clearly, over the years procurement personnel have acquired considerable experience from their failures as well as their successes. The Army continually studies its own procedures and has made modifications[7] to correct deficiencies. A summary of these procedures is in the book used by the Army Management Engineering Training Agency (AMETA)[8] in a course taught to engineers involved in TDP construction. Furthermore, Army procurement personnel from the various commands meet at irregular intervals to discuss their experiences and present to each other methods they use for improvement.

The process described briefly above is a specific type of technology transfer. An item is developed and tested satisfactorily. The manufacturer may not be the developer and therefore the technology must be transferred. This is a problem common to most all government agencies and to industry as well. Because the items involve the selection, treating, shaping and assembling of materials, the Army's request to the National Academy of Sciences was referred to the National Materials Advisory Board. They were asked to examine the use of the Army TDP in making this transfer and to compare its effectiveness with the technology transfer methods used by other Services and by industry.

C. Methodology

The Technical Data Package of the U.S. Army is the documentary part of technology transfer from a developer to a manufacturer. In practice, after the

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[7] "Impact Program Report - Technical Data Package Improvement." Report No. 1. U.S. Army Materiel Command, Washington, D.C., November 1972.

[8] "Technical Data Package Development and Management: Army Management Course." 4th ed. U.S. Army Management Engineering Training Agency, Rock Island, Ill., 1974.

TDP is believed to be ready, procurement personnel solicit bids and write the procurement contract. The Committee considered the preparation of the TDP and procurement as two separate steps in technology transfer and conducted its studies accordingly.

All available Army reports and regulations pertaining to the preparation of TDPs, as well as other pertinent reports, were studied (section VII). Presentations were made formally to the Committee by senior Army employees who are involved in various phases of teaching, performing and reviewing the technology transfer process (Appendix A). The Committee also heard presentations from Navy and industry representatives as well as from Army and Navy attorneys who are involved in procurement practices. These general presentations were followed by in-depth interviews of individuals who have over-all responsibility for procurement in Army, Navy and industry. This report contains summaries of those techniques which utilize somewhat different approaches and thereby contain ideas which might be tried experimentally for the procurement of various items. Five TDPs, one from each of five Army commands, were examined in detail to determine the adequacy of documentation and reasons for the engineering changes approved for each. The number of changes in three TDPs due to errors was compared to changes for similar reasons in the automotive industry.

The Committee identified nine specific problem areas and developed a list of possible modifications of Army procedures. These were reviewed for their legal implications by the Committee and liaison attorneys.

III

THE ARMY TECHNICAL DATA PACKAGE

A. General

Competitive procurement obviously cannot be considered without a complete and reasonably accurate technical data package. The accuracy, completeness, currency, clarity and adequacy of the TDP are major factors in determining the method of procurement that can be used or the number of qualified competitors that are available.

The items procured with a TDP are of two types, i) off-the-shelf items with or without minor modification and ii) items that must be designed for the military. The concern of this study is with the procurement of the second category of items.

The development procedures for the TDP and the assignment of responsibility at each stage are governed by Army Materiel Command Regulation (AMCR 70-46). The TDP includes but is not limited to the following: specifications, drawings, repair, parts lists, packaging, data sheets, quality and product assurance data, special production tool drawings, acceptance and inspection equipment drawings and other data as required.

B. Army Management Engineering Training

The Army Management Engineering Training Agency (AMETA) offers a two-week course on the Technical Data Package Development and Management and uses a course book with this title.[9] The course covers "policies, procedures and responsibilities for the acquisition, preparation, review, proofing, maintenance,

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[9] "Technical Data Package Development and Management", United States Army Management Engineering Training Agency, Rock Island, Ill. 1974.

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improvement, control, and transmission of the Technical Data Package for procurement and production of United States Army Materiel Command materiel."

There is no requirement that anyone responsible for developing TDPs or for procurement take the course and there is no qualifying examination.

C. Command Variation

The breadth and diversity of the development and procurement programs of the Army are extreme. For this reason, the established policies and procedures permit versatility and flexibility, and thereby each Command can choose the optimum procedure for a given item. For example, an item developed in-house will have a different "style" of review than one developed under contract, or the description of an electronic device may depend more on function specifications than on detailed drawings. The five TDPs reviewed below were selected by five different Commands to indicate some of the diversity of permissible procedures.

D. Examination of Representative TDPs

1. Army Electronics Command (ECOM) AN/APM-123(V) Transponder Set and AN/X URM-103 Signal Generator

a. Background

ECOM is responsible for those electronic weapons and hardware not purchased and managed as components of one of the large weapons systems developed by one of the other Army Commands (such integrated components as missile control electronics). Quantities involved in ECOM procurements range from the tens to the thousands. The Configuration Items (CIs), although sometimes quite complex, fall within the development and production capability of a large number of suppliers, and the command is able to make very good use of competitive purchasing.

b. AN/APM-123 (V)

The AN/APM-123(V) Transponder Test Set is a special purpose piece of test equipment used in the adjustment and maintenance of the identification transponders carried by aircraft of all three Services. The Army contracted for the development of the APM-123 beginning in 1959. By 1963 the development had proceeded through the development, model testing and field evaluation phases and improvements, resulting from these evaluations, had been incorporated in the design.

Formation of the Department of Defense Airborne Identification Mobile Systems (AIMS) organization in 1963 led to the Army's being assigned the task of providing a transponder test set suitable for tri-service use. In 1965, the APM-123 development contractor submitted an unsolicited proposal to modify the original design to make it suitable for tri-service use. The contractor's proposal was accepted and a contract was negotiated on a sole-source basis for the redevelopment and initial production of 374 units. A technical data package suitable for later reprocurement was included. The equipment was highly successful and a follow-on contract was awarded to the original supplier (sole-source) in 1967.

Numerous changes were incorporated in the equipment and, therefore, into the technical data package during the initial production runs and some difficulty was encountered in obtaining a complete and up-to-date data package for reprocurement, but a satisfactory package was eventually put together. Another firm was the successful bidder and received a contract for 250 test sets at a price one third as great as that for the first two production runs with the developer. A second contract was later negotiated with this second vendor for another 584 sets at about the same price as his first order.

Thirty-six engineering change proposals were approved during the first contract with the second source and four changes were made during the second contract. Of these 40 changes, 24 were for minor data deficiencies and only eight of these were for actual data errors. The total cost growth for all

changes, including the cost of desirable evolutionary design and product improvements, was only $4400. Only $200 of the increase on contracts of more than $1 million was caused by data deficiencies; however, no data were available for the cost of these changes on the parts inventory.

c. Conclusion

Although this example was not chosen as necessarily representative of the average reprocurement, it does illustrate that it is possible to use the TDP successfully to transfer the information necessary for a new vendor to produce without significant technical difficulty and at low cost.

d. Equipment Verification Review and the AN/XURM-103

The transponder test set reprocurement occurred before the adoption of the newer Program Management and Configuration Management Techniques. Upon completion in November 1972 of the Army multi-command Impact Program study of the effectiveness of the Army's data management program,[10] each of the commands established policies and procedures aimed at improving substantially the designs and the data packages produced by Army development programs.

The ECOM procedures as stated in the final report of the Impact Program called for five specific reviews related to (i) a Physical Configuration Audit (PCA) measuring the compliance of the physical product with its data package, (ii) a Drawing Verification/Producibility Review measuring the adequacy of the drawings for compliance to specifications and for suitability for efficient manufacture, (iii) an in-house ad hoc review of the data package to determine suitability for reprocurement, (iv) an Equipment Verification Review (EVR) of a sample of the production output of the successful production supplier, (v) a Cost Growth Report (issued periodically).

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[10] "Impact Program Report - Technical Data Package Improvement." Report No. 1, U.S. Army Materiel Command, Washington, D.C., November 1972.

To assess the effectiveness of these new procedures, a relatively simple audit was made by examining several of the more recent design and data reviews which have been called for under these new disciplines. The program selected by ECOM for audit is the AN/X URM-103 Signal Generator, a typical piece of electronic test equipment.

Documentation for the contractor review, the ECOM analysis, and the resolution of the discrepancies have been analyzed as part of the audit. The contractor, during his review, found that the equipment deviated from the drawings in 110 cases, involving 54 drawings. All of these were minor discrepancies, involving no fundamental design deficiencies, and most of them were corrected immediately. The contractor requested waivers for an initial small quantity to avoid significant rework he felt was unnecessary. Twenty-six minor drawing errors were uncovered by the audit. EVR and ECPs were still in process during the audit.

The subsequent correspondence pertaining to this matter showed an admirable discipline and fairness on the part of ECOM. Rulings on action to be taken were prompt, fair, clear and explicit and made no compromise to the disadvantage of the Army. Requests were granted in cases in which there was no disadvantage to the Army and relief was possible for the contractor. The cost increase to the Army of all the changes implemented including design improvements, was negligible.

The ECOM responses give evidence of meticulous care in establishing on an item by item basis, the contractor responsibility for making the corrections and in outlining the necessity for following the review procedures in determining that the corrections had been made.

2. Army Armament Command (ARMCOM) -- M68 Gun

a. Background

The 105mm M68 gun has been in existence for a long time. It was standardized in 1959 and full-scale production was started in 1960. Since that

time many complete guns and spare gun tubes have been produced. Gun tube and ammunition for the M68 are directly interchangeable with the United Kingdom's counterpart, and at least 20 countries are currently using this gun system.

b. Development Program and Data Preparation

The M68 gun was completely developed as an in-house activity at Watervliet Arsenal where a wealth of experience and knowledge concerning gun design and manufacture is available. Watervliet Arsenal also possesses unique laboratory test facilities in which pressure confining components (tube, breeching and breech block) can be tested for durability under simulated firing. Also Watervliet has evolved manufacturing techniques which are special to gun tube production. Methods of cold working gun tubes by swaging and autofrettage are special processes for which equipment and technical expertise are available. These capabilities are not readily available in the industrial community.

The in-house gun advanced development follows an iterative process in which designs, subjected to independent audits are built and tested. Physical audits of development designs include 100 percent measurement of component parts. Feedback from the test program is reflected in revised designs and the process is repeated. The advanced development programs include both the conceptual and the validation phase.

The next phase is engineering development, which includes a development program and a producibility engineering and planning program. In the development program, the updated development design is again audited and the engineering development prototypes are manufactured. All parts are again subjected to 100 percent measurement and prototypes are tested. Service life tests also are conducted either at a range or laboratory and the items are cycled to the end of their useful life.

Concurrently with the prototype manufacture, a Producibility Engineering and Planning Program is initiated. Supplementary Quality Assurance

Provision (SQAPS), gauge design and other product assurance plans are prepared for the TDP. At the completion of the engineering development phase, the TDP contains the best integrated thinking of all parties who are involved.

Watervliet prefers to do its own in-house checking of drawings. Its personnel have occasionally used a third-party review, but management apparently has greater confidence in checks and audits performed by in-house personnel who have pertinent background and experience. The proof of the TDP is next demonstrated in the low rate initial production phase (LRIP) in which initial production models are used in an initial production test (IPT) of the cannon. This phase proves that the conversion from development to production drawings has not degraded the performance and reliability of the product.

It is noteworthy that each time a new production line is started and whenever there is a major process change the IPT is repeated. The production process is one that is constantly monitored and tests are specified whenever the normal production process may be disturbed.

Watervliet does not include Reliability, Availability and Maintainability (RAM) requirements in the TDP. Since the TDP has been based upon an iterative process of testing, evaluation and redesign, management believes that the drawings and associated documents in the final form of the TDP assure that RAM requirements are satisfied.

The TDP is developed in a close-knit, in-house organization, where all input elements are in close proximity. Provisions for necessary auditing of the TDP seem to be amply provided, although the Committee was not able to obtain any check-off lists or formal documents for assuring the completeness and accuracy of the TDP.

It is noteworthy that during subsequent procurement activities, for items which are not to be built in-house, prospective bidders are purposely made aware of the risks involved in the production of items which require extremely high levels of quality. Complete information is made available to these people

Bidders Conferences

so that there are no surprises after the production order has been placed. Pre-award surveys further help to eliminate bidders who do not have adequate facilities to produce or who do not understand the levels of quality which are required.

Over the years, changes in the TDP for the M68 gun have been minor. Most changes have been to update material and process information to reflect changing material costs and the availability of new and better manufacturing processes.

c. Conclusions

For programs in which the development engineering and the production may be done under the same roof, the technology transfer is unquestionably smoother than it is from a government procurement agency to a commercial house. This is particularly true if the people who are going to manufacture the item have had an input to the TDP. There is no question that the present TDP for the M68 gun is an excellent document for transferring technology. It offers minimum risk of misinterpretation and it presents objectives which are attainable. The principal reasons for the high level of quality of the TDP are:

i) The technical data package for the M68 gun has been in existence for a long time. The original data were probably accurate to start with and they have tended to improve with age and use. Every part of the M68 gun, with the exception of the breech ring, has been procured from domestic outside sources. All components of the M68 gun have been successfully manufactured by friendly nations from the TDP.

ii) The development is conducted entirely (with the exception of some firing range work) in-house, essentially under one roof. The TDP is the integrated effort of this close-knit operation.

iii) The personnel at Watervliet are specialists in gun development, and they have excellent supporting strength in manufacturing and laboratory evaluation.

iv) The development program is so structured that each increment of improvement in data generated is audited by all concerned groups and it is confirmed by actual firing tests or by simulated laboratory tests. Physical Configuration Audits of 100 percent are commonly used in the development phase.

v) Low Rate Initial Production is used to verify that the TDP will, if followed, produce guns which meet the performance requirements.

3. Mobility Equipment Command (MECOM) -- Ribbon Bridge

a. Background

The need for a new tactical bridge system in the U.S. Army inventory became apparent in early 1968. At the same time, intelligence data indicated excellent performance and widespread acceptance of the Soviet bridge. A requirement was subsequently established for a Ribbon Bridge System that would be similar in operation to the Soviet bridge and a contract for the development of the Ribbon Bridge was awarded in June 1969. The development contract was the responsibility of the U.S. Army Mobility Equipment Research and Development Center (MERDC).

The development contract called for data items to be supplied in the form of technical reports, drawings, engineering and associated tests, design data and technical publications. Final drawings were to conform to Form 1, MIL-D-1000, Category E. The contract further specified that the contractor would: i) validate each drawing and other design disclosure document against the item depicted; ii) certify that each drawing and other design disclosure document accurately and completely represented and described the related item, equipment, part, or assembly; iii) certify that each such item had been manufactured and supplied in accordance with such drawings or other design disclosure document; and iv) certify that all technical data furnished conformed to the applicable requirements of the contract. The contract further specified that technical data furnished

by the contractor would be subjected to preliminary and final design review by the assigned contracting officer's representative (COR) at Fort Belvoir, Virginia.

b. Development Program and Data Preparation

The results of the development program and subsequent engineering design tests (EDT) were very encouraging, and the basic system appeared to be well suited to the functional requirements. The development program, however, failed: i) to identify some fundamental design deficiencies in the joints of the aluminum fabricated structure; ii) to generate a set of technical data that could form the basis for a quality TDP; and iii) to provide the necessary configuration audits to identify the basic differences between the prototype parts and the drawings that were submitted under the contract.

Subsequent Engineering Tests (ET) and Service Tests (ST) of the prototypes revealed deficiencies, principally in the durability of welded joints, that necessitated a redesign effort and major design changes were made. This might normally require that new prototypes be fabricated and tested to confirm the effectiveness of the changes. At this point, however, it was apparently decided to take a calculated risk and proceed to the production phase without substantiation of the design changes. The design changes in the fabricated structures appear, from a paper study, to be an improvement over the original prototype design. However, uncertainty arises because there has been no test verification to demonstrate that the new design will meet the reliability and maintainability requirements. Substantiation of the new design will not be confirmed until initial production tests (IPT) are conducted by Army Test and Evaluation Command in the summer of 1975.

The data generated by the developer proved to be plagued with errors. Third-party reviews were used extensively to disclose and correct

drawing errors. Many drawings submitted for prototype parts became of questionable value in the light of design changes which followed the engineering and service tests. The government's representative on the development program apparently did not have the opportunity to monitor the data being generated at the level that would detect drawing errors. The two design reviews held during the development program were not penetrating enough to identify weaknesses in the design, which later led to fatigue failures in the service tests.

During the development program there appeared to be inadequate in-process monitoring of the fabrication. This was particularly true of welds which became visually inaccessible when covered by subsequent assemblies. No Physical Configuration Audit was made of the prototypes and tolerances which were presumed to be met were never verified. These same tolerances, when included in the TDP, were correspondingly not met in the first production units.

There are no specifically stated reliability, availability and maintainability (RAM) requirements in the Technical Data Package. MERDC reasons that the design was based upon RAM requirements and therefore the drawings and associated documentation in the TDP will produce items which meet the RAM requirements. In principle this may be true, but in this specific instance the TDP is considerably different from the items that went through Engineering and Service Tests. Apparently, the IPT tests of production units will be the first demonstration of the reliability of the latest design.

c. <u>Production Program</u>

On the basis of a TDP that contained untested design features, a production contract was awarded in May 1973. Included in the contract is a preproduction evaluation clause (see section IVB), and the production contractor will eventually perform a configuration item verification review on production items. This will validate that the end item being produced and all its components conform to the production baseline documentation (contract TDP plus approved changes).

To date, over 100 ECPs have been approved; six have been government initiated Class I changes which cost about $12,000, and five have been contractor-initiated Class I changes that will cost about $155,000. Additional ECPs are being processed by the contractor, the cost of which will be well into six figures and these will have to be argued and negotiated. Not all engineering changes, however, have added to government cost since under the value engineering incentive provisions of the contract, cost saving changes have also been introduced.

The major problems that have plagued the production contractor and that are the potential sources of ECPs can be summarized as follows: (i) difficulties in meeting specified tolerances; (ii) government design inspection gauges which have not been adequate for the purpose and which require redesign; (iii) contractor and government differences in interpretation of the Preproduction Evaluation Clause.

d. Conclusions

Recognizing that the Army regulations which were in effect at the beginning of this program are different from those which are reported to be in effect today, the Ribbon Bridge program cannot be evaluated fairly using current regulations. Nevertheless, it appears that several important lessons relevant to the more recent procedures for technology transfer can be learned from this experience. These lessons are:

(i) Early successes in functional performance do not eliminate the need for a high quality Technical Data Package.

(ii) Configuration audits are essential to assure that prototype equipment and the drawings correlate, and if not, why not.

(iii) The development contractor should have been required to assure the accuracy of the data which he was obligated to provide under the contract and the Army should have monitored the data more carefully.

(iv) Short cuts which by-pass standard discipline and procedures are hazardous.

4. Munitions Command--M567 Fuze

a. Background

When dealing with munitions, allowed flexibility is fully utilized. In addition, the Mobilization Requirement (see section VA6) permits the sharing of the total procurement between two or more manufacturers. Also, safety dictates that greater coupling be practiced between procurement personnel and the development group at Picatinny Arsenal. Before every procurement, the procuring agency contacts the developer and asks him to certify the adequacy, accuracy and completeness of the TDP. In turn, for every procurement, the engineering staff checks the TDP, bringing up to date the latest standards, specifications and materials data. Field deficiencies and deviations also are reviewed.

In addition to the above procedures, Picatinny Arsenal utilizes a classification of their TDPs which in movie parlance they describe as follows: GP -- a proven TDP good for procurement by essentially any manufacturer, large or small; R -- a package restricted to only qualified bidders whom the engineering personnel recommend as having the manufacturing capability; and X -- a development or unproven package that only specialty firms may consider. Essentially all munition item TDPs are tested by limited production runs before full-scale production contracts are signed.

b. Fuze Procurement Procedures

This fuze is for mortar application and is similar to others in production. Basically, it is designed around precision die casting in order to eliminate some of the complicated secondary machining operation. The unusual difficulty in technology transfer for this type of item is that there are few experienced fuze manufacturers, but in time of national emergency hundreds of thousands of precision fuzes are needed with a short lead-time. Picatinny's own team of

engineers interact with new manufacturers, assisting them with the tooling, manufacturing techniques and quality control. Thus, technology transfer is not accomplished by the TDP alone.

The treatment of allowed tolerances of fuzes is of interest. On the drawings is printed the following:

> "Compliance with functional requirements are mandatory. The government does not guarantee all possible combinations permitted by tolerance limits will consistently satisfy test requirements. Contractor must choose those combinations of tolerances within the limits of specifications and drawings which suit his process and still satisfy testing requirements."

This seems to be a fair statement of the degree to which the TDP is warranted and what is expected of the contractor.

c. Conclusions

The TDP for the M567 fuze was examined and it was concluded that it is specified with sufficient detail to successfully transfer manufacturing know-how from arsenal manufacturer to outside subcontractors. Not only is the fuze itself specified but the manufacturing techniques are outlined and are known to produce a satisfactory item.

5. Missile Command -- The Pershing Missile Second Stage Rocket Motor Case

a. Background

The original design of this rocket motor case for the Pershing Second Stage had a heavy wall motor case which was made of rolled and welded 4130 steel. The later flight weight cases were designed using the same configuration except that H-11 steel was used. The forward and aft closures were forged and the cylindrical portion was hydrospun. The H-11 steel cases were notch sensitive and exhibited hydrogen embrittlement. Both of these disadvantages were minimized by controlling the amount of decarburization of the steel during heat treatment.

The Pershing case was released for production with two changes: i) D6AC steel was substituted for H-11 because it is not as notch sensitive or as prone to hydrogen embrittlement, and ii) bolts were substituted for rivets in the attachment of the forward skirt to the motor case. Cases were procured at a steady rate with no significant problems.

b. Conclusions

The item is simple with a few drawings, specifications and quality assurance provisions and there are no problems in stacking or in relationship of one part to another. The TDP is based on functional requirements which allow development of manufacturing techniques by a contractor. The TDP calls for progressive reviews by the contracting agency and the contractor to meet a required operational capability. The package appears to be complete and includes referencing to administrative techniques and feed-back from contractors. Producibility was safeguarded with appropriate joint configuration audits.

The Committee reviewers were satisfied that high quality components could be made from this TDP since it appeared complete and if given proper administration by qualified agency personnel would produce satisfactory procurement programs.

E. Some Contractor Criticisms of Recent Army TDPs

A limited solicitation for criticisms resulted in the following comments concerning some recent Army TDPs:

1. Proprietary or Source-Controlled Items

DoD development strategy as expressed in ASPR permits a contractor to retain proprietary restrictions (sometimes unavoidable), thereby withholding information necessary for adequate quality, acceptance and performance test validation.

2. Inadequate Product Quality Assurance Requirements

Manufacturing processes and/or techniques are not always adequately depicted where they are critical to assuring proper performance. Proprietary items require a qualified products listing depicting known manufacturers of properly performing quality items. This listing, when available, is not always adequately controlled and maintained.

3. Timely Status of TDPs

Comments were received from industrial contractors to the effect that Army had solicited bids for TDPs which were not currently up to date. When originally issued, the TDP had been considered highly satisfactory but upon reprocurement a number of proprietary items or materials called for were no longer available.

4. Preproduction Evaluation and Patent and Latent Defect Clauses

Criticisms have been received from industry representatives concerning the implications of contract clauses such as the Army's Preproduction Evaluation (section IVB) and the Navy's Patent and Latent Defect Clause (section VA3) both of which place the burdens for some undiscovered drawing errors on the manufacturer after production has begun. Although the successful bidder is given a reasonable length of time and may increase his bid to cover the costs of checking the TDP, the checking process does not ensure that all errors will be discovered. After production has begun all obvious drawing errors are the responsibility of the contractor even though corrections may require engineering redesign. Industry's view is that such clauses could lead to false economy through a relaxation of reviews of developer-prepared TDPs and that the burden on the bidder can be unreasonably large. They consider the philosophy of such clauses to be highly unfair and a possible deterrent to bidding by reputable manufacturers.

It should be noted that the above four items list only criticisms of some TDPs from some contractors and the Committee makes no general implication that these faults occur with all TDPs.

IV

EXTANT METHODS OF IMPROVING THE TDP

In this section four techniques commonly used for TDP improvement are reviewed. The Army sometimes uses them with varying degrees of success. Because such a variety of items is procured with TDPs there is no single "best" method. The Committee's view on the applicability of these techniques is included in section VI.

A. Independent Party Review

The phrase "Independent Party Review" will be used in this section to describe all of the methods of review of the TDP documents by individuals other than the data preparers.

1. Ideal Checking Procedures

Ideal drafting practices call for at least three separate checking operations by independent parties during design and drafting prior to drawing release. During the mechanical design process the drafting designer, under the technical supervision of the responsible design engineer, prepares a master layout drawing, documenting each detail part and its assembly into the complete device. When this working layout is completed it is checked thoroughly, both as to the overall functioning and the detailed parts, by another drafting designer skilled in layout checking. This designer recomputes those tolerance and other calculations he feels are necessary to verify that the design is suitable for the function and for manufacture.

The checked master layout then is turned over to a detail draftsman who, under the supervision of the design draftsman, prepares the finished detail drawings of all of the parts included in the layout. Each of these finished detail

drawings is then checked for accuracy and completeness by an independent detail drawing checker. The "loop" is then closed by an independent design draftsman who uses these finished and checked detail drawings to reconstruct a new assembly drawing, which is then compared to the master layout to double-check that the whole can, in fact, be created from the parts. If followed with discipline, the above conventional procedure can be depended upon to produce documentation with few data errors.

The drawings and other data making up the Army TDP are subjected to a checking procedure which involves the Army engineering representatives, who sign off on every document. This review is then endorsed with an approval signature for the Army. (This approval is not always by a different person from the person who performed the review.) Thus, a formal TDP drawing typically shows the signatures or initials of the preparer, the checker, the Army reviewer, and the Army approval authority.

2. Prototype Construction and Evaluation

The technical data receive a most important and comprehensive independent party review when the data are used in the actual construction of the first model. Drawings for parts to be made in-house are given to the shop personnel who manufacture the first parts and in the process spot errors, omissions, and impractical requirements. Vendors for parts purchased outside fulfill a similar function in improving the drawings for these parts. Much of the value of this review will be lost if the information concerning discrepancies and errors is not reported to the designers promptly and used with discipline to up-date the data.

Functional proof tests of the prototype(s) always disclose additional errors or necessary changes that must be corrected and incorporated in the data package and tested by the construction of a final preproduction model.

3. Third Party Reviews

The Army has on occasion carried out, either with its own engineering personnel or by contract with a specialized engineering firm, a thorough review of the formal TDP. Impressive evidence was presented to the Committee showing that a thorough review by professionals can detect 90 percent of the data errors in a TDP package. Such a review can convert a bad package to one of satisfactory quality.

Review by a qualified engineer who specializes in such a service can offer an additional valuable benefit. In the review process the data adequacy and design weaknesses will also be spotted by the reviewers. Suggestions for improvement of the design-to-function can be expected as a by-product of the data review. It should not be concluded, however, that a data review is equivalent to a design and data review. A much more comprehensive engineering task is involved in a complete functional design and data review than can be expected from a data review. Whether a data review or a design and data review should be undertaken can be determined by deciding whether the quality of both the design and the data are suspect.

sampling method ok

4. Vendor Review

Another tool for insuring adequacy of the TDP used in production procurement is the practice of contracting with the actual or prospective production supplier(s) for a thorough review of the TDP for adequacy and for producibility. A more extensive description of this procedure, called Preproduction Evaluation, is contained in the next section. For the purpose of the present discussion, it can be concluded that these procedures are valuable, where it is appropriate to use them, in insuring an adequate data package.

← not as good a practice as compared to in-house review

B. Preproduction Evaluation

The Army has adopted a procedure called Preproduction Evaluation to overcome some of the difficulties that have been encountered in using Technical Data Packages for competitive procurement.[11,12] In summary, the procedure provides that the successful contractor will conduct an evaluation of the TDP immediately after contract award but prior to the commencement of production to discover the obvious drawing errors and deficiencies. This effort is included in the schedule of the contract and the bidders are expected to provide sufficient funds in their price to support the evaluation.

Since many TDPs have not been used for production at the time they are [illegible] in a procurement, this procedure is a feasible way to obtain a thorough screening of the TDP at an early state. The clauses used in contracts incorporating this technique are not completely clear but they seem to state that the contractor is responsible for any design deficiencies in the TDP whether these deficiencies are found during preproduction evaluation or during performance of the manufacturing work on the contract. The clauses therefore throw a great deal of risk on the contractor even when the deficiencies are not discoverable at the time of bidding. The underlying assumption of this arrangement seems to be that the contractor should be held responsible for this risk of defective government drawings because he is being paid to find the defects in the drawings immediately after the contract is awarded rather than during manufacturing. However, there is no way the contractor can cover the risk of undiscoverable defects in the price except by the inclusion of a contingency based on a guess as to the merits of the design.

not realistic - contractor cannot be held responsible for an incorrect design

[11] "Procurement: Preproduction Evaluation Contracts." AMCP 715-6. U.S. Army Materiel Command, Washington, D.C., May 1970.

[12] Frederick W. Helwig, K. D. Griffiths, and K. D. Newlin. "Technical Data Package Improvement: Preproduction Evaluation." APRO-204. Army Procurement Research Office, U.S. Army Institute of Logistics Research, Fort Lee, Va., 1975.

Forcing bidders to include such contingencies under the pressures of competition is not a sound practice in terms of inducing the most competent companies to bid on Army jobs (see a summary of industry views in section IIIE4). Further, it appears that this contract clause is leading to a significant amount of controversy between contractors and the Army and that there is substantial difference of opinion on the legal merits of the clause. The Navy has a somewhat different clause (see section VA3).

C. Product Assurance in TDP Improvement

During product development, its reliability, availability and maintainability, and safety are paramount design requirements, and their quantitative goals should be included in the performance specification (see appendix B).

If the development program is properly structured, effective, in-depth design reviews are held, physical and functional audits are made, and meaningful development testing is performed, the product should have demonstrated that it does satisfy these requirements. Therefore, the drawings and associated data which go into the TDP should describe the product which meets the Reliability and Maintainability (RAM) and safety requirements. The accuracy of the description will depend to a large extent upon the accuracy of the drawings and associated data. The extent to which the producer builds to the drawings and associated data depends upon the quality assurance provisions. These assure that the part conforms to the drawing and to all other instructions included in the TDP. Thorough inspection and acceptance testing plans serve to insure the acceptability of the parts. Tests of this nature do not and should not place upon the manufacturer the design responsibility for the RAM and safety requirements, but should cover his responsibility for assuring that the manufactured product meets the requirements of the TDP.

V

OTHER APPROACHES TO TECHNOLOGY TRANSFER

A. U.S. Navy

1. General

This section of the report contains some methods used by the Navy that differ from those employed by Army. Although the Committee did not determine the overall effectiveness of these methods, they are deemed worthy of Army consideration.

The Navy is organized into three basic systems procurement commands: Naval Sea Systems Command, Naval Air Systems Command, and the Navy Electronic Systems Command. Each Command is responsible for its own hardware and supplies development and production (including procurements and data management).

The Navy puts heavy emphasis on selecting contractors in whom it has high confidence. Competitive production procurement is used only when the Navy is convinced that this route will result in high performance, high quality, and best value. One of the reasons for this approach is the nature of Navy purchases. The average program is larger in size (a single carrier may cost more than $1 billion), and the unit volume is correspondingly smaller. Some of the small missiles, certain electronic equipment, supplies, and ammunition have sufficient unit volume to justify competitive reprocurement. The Navy does have a breakout program under which subsystems and equipment suitable for competition are procured competitively.

2. Advanced Procurement Planning Regulations

The Navy operates under the general Armed Services Procurement Regulations and DoD general policies and regulations. For example, ASPR 1-100 and 1-2100 apply for general procurement and for Advanced Procurement Planning,

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respectively. In its own implementing regulations, the Navy augments the ASPR regulations.

3. Producibility Evaluation

The Navy's approach to handling the producibility evaluation clause in procurement contracts is somewhat different than that used by the Army in Preproduction Evaluation. In a correction of defects clause used in contracts the Navy distinguishes between "patent" and "latent" defects and specifies that it will bear full responsibility for latent defects in the data package and the contractor will bear full responsibility for patent (or should-have-been-obvious) defects. By making its definitions more precise and conceding responsibility for those defects that the contractor could not have been expected to uncover before commencing production, the Navy strengthens its case to hold the contractor responsible for defects in the data that a good, comprehensive and complete review would have uncovered. (See appendix C for a discussion of the background of this clause and the general form of the clause itself.)

good approach this is like a warranty

4. Naval Weapons Engineering Support Activity

The Navy maintains an organization for which there is no direct Army equivalent. It is the Naval Weapons Engineering Support Activity which serves the entire Navy but is physically located in the Naval Air Systems Command.

good

The Product Engineering Department of this Activity provides a service capability in TDP review, production support services, configuration control evaluation, and breakout program engineering support. The personnel include a cadre of skilled production engineers thoroughly familiar with Navy data specifications, configuration management, engineering support needed for competitive procurement, and industrial manufacturing techniques and capabilities.

The Department is a service agency available, under internal work order, to perform audits of Technical Data Packages, conduct pre- and post-award contractor evaluation and surveys, evaluate claims, disputes, and contractor

proposals, and perform functional and physical configurations audits. A brief survey of the activities of this Department determined that providing this specialized capability across the Service is a significant aid in insuring discipline in program, project, and configuration management policies and in providing special talents to review particularly important procurement programs.

5. Methods of Ship Procurement and Parts Control

It is of interest to examine briefly the experience of the Navy in their attempts to transfer technology for the building of a given ship from one shipyard to another where construction methods may differ.

Initially, a functional specification and about 50 drawings are prepared to describe the ship desired, and bids are solicited for first procurement. The winning bidder proceeds to construct the ship according to the methods used in his yard and to prepare detailed drawings as the work progresses. Historically, these drawings have not reflected in detail many of the engineering "fixes" done in the shipyard. Purchased parts were described only in functional specifications and sometimes the parts had to be modified to fit a given configuration. The resulting proliferation of spare parts began to pose serious problems.

In 1968, the Bureau of Ships initiated a parts standardization program. In this first attempt, it established a list of qualified parts when there existed three or more "identical" ships and offered a scaled bonus to the contractor which depended on the percentage of listed parts he used in the reprocurement ships. This naturally led to careful cost analysis by the contractor to compare the savings he could achieve by using a different part to the bonus offered for using the list part.

Next, a penalty approach was tried. Because the administrative costs of introducing a new Federal Stock Number (FSN) was about $3,000, the contractor was required to pay this penalty for every unlisted part used. However, for reasons such as delivery schedule, listed parts did not meet specs, etc., reasonable exceptions had to be allowed, and experience showed that the contractor almost always had a valid excuse for selecting an unlisted part.

A third approach to the standard parts problem is being tried in the procurement of the FFG-7 (a guided missile frigate). The Navy plans to acquire 50 of these ships over a several-year period, although it is recognized that appropriations or changing needs may terminate the acquisition at any number. The leader shipyard, i.e., the one building the first ship, is paid to obtain options on components for the remainder of the planned ships. The options are dependent upon their being exercised at a predetermined production rate. Escalation clauses and delivery dates are, of course, included as part of the option provision.

Returning now to the problem of technology transfer where different construction methods are included, the Navy has analyzed its experiences and has arrived at methods quite similar to those currently being introduced into Army procurement.

Originally, the Navy told prospective follow-on bidders that the specifications could be acquired from the first producer at the cost of reproduction. However, the Navy disclaimed all responsibility for the accuracy of the drawings. This procedure was considered unfair because the degree of accuracy of the drawings could not be assured and the reprocurement bidder was often faced with high development costs while the government got the benefit because of its disclaimer of responsibility.

conflict of interest w/first producer

Beginning in 1970, the Navy made a procedural change. It recognized that it had insufficient manpower to examine all the drawings and to assume responsibility for their accuracy. Furthermore, the small numbers of each ship precluded verification of drawings by prototype construction. Thus, it purchased the drawings with the awareness of deficiencies and paid the successful bidder to review the drawings and make corrections. All patent defect corrections subsequent to this review were to be paid for by the bidder within the approved contract cost while the Navy agreed to pay for any latent defects which appeared at a later time in construction. Under this procedure, the bidder recognizes that the government

is willing to share the risk of deficient drawings. No claims have yet developed under procurement using this method, thus it is still too soon to draw conclusions. Note that this method, discussed in section VA3, is being used by the Navy in the procurement of other items.

The Navy does not normally require conformity in ship building to detailed drawings. It is recognized that there are differences in shipyard techniques and that a reprocurement contractor may want to introduce his own cost-saving methods. He therefore is offered the choice of using the above procedure with existing drawings made by the first producer or using the original ship drawings and functional specifications. Note that this procedure is not used in the procurement of nuclear powered vessels because of the much higher quality control exercised in every step of the construction.

In the specific case of the 50 FFG-7s mentioned above, there is an additional problem of time for technology transfer. Five to seven years are required to build and test the first ship. The Navy requires the ships at a rate that does not permit such a lag time. The leader company is therefore given a 24-month lead on the construction of the first vessel. As the ship is built the leader company is paid to develop and validate drawings which are then given to the reprocurement shipyards. The leader company is also contracted to keep all drawings up to date and to notify the follower companies of any changes.

6. <u>Experience in Technology Transfer for the Sidewinder Missile</u>

The Armed Services Procurement Act has 17 exceptions to the requirement for open bidding for procurement. Of these, Exception 16 is the requirement for mobilization (ASPR 3-216). Items falling into this category are those that have a continuing peace-time need and a much larger requirement in the case of national mobilization. Manufacturers wishing to participate in such an arrangement must sign an agreement with the DoD to keep stand-by equipment ready for production. Under Exception 16 two or more contractors may be required to achieve the production capability in the event of mobilization, to insure facilities in different

geographical locations, etc. The Navy has used this two-contractor requirement in the competitive bidding for several items, an example of which is the Sidewinder Missile (AIM-9D).

The original Sidewinder[13] was conceived by the Naval Ordnance Test Station (NOTS), now the Naval Weapons Center (NWC), in the early 1950's. Subsequently, a contractor was selected for both pilot production and to develop and prepare a data package for the guidance-and-control unit of a later version of the Sidewinder, the AIM-9D. In 1964 the Navy advertised for reprocurement and the second source bidder was 40 percent below the original cost. Under the terms of the contract, the second source had to qualify as a producer by successfully manufacturing and testing a guidance control unit, and in this step it encountered difficulties.

Although the data package included about 1000 drawings of the parts and testing equipment, it did not include process information or assembly instructions. Further, there was no contact between personnel of the second-source and original companies.

The second producer claimed that the data package was inadequate and that many of the components had to be reworked to meet specifications. In a suit against the Navy, the second producer was awarded a substantial portion of its claim.

In subsequent bidding for reprocurement under the mobilization requirement that there be at least two producers, the Navy was able to award the greater part of the production to the lower bidder, a technique that encouraged even lower bids on successive reprocurements. However, because of the difficulties in technology transfer in the first reprocurement, when modified Sidewinders, e. g.,

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[13] G. A. Carter, "Directed Licensing: An Evaluation of a Proposed Technique for Reducing the Procurement Cost of Aircraft," R-1604-PR (Rand Corp., Santa Monica, Calif., 1974).

AIM-9G & 9H, were competitively bid, the second producer who had introduced the modifications was paid to identify incompatibilities between the data package and the specifications.

This experience, described very briefly, has three important points applicable to the present study:

i) The ability to keep two or more producers manufacturing the same item with an award of the larger part of the production to the lower bidder can result in savings in successive reprocurements.

ii) The force of competition between two or more manufacturers in concurrent production encourages them to strive hard to improve the product and to introduce cost savings in production.

iii) Even in such a successful procurement system as this there are difficulties in attempting to transfer technology for production with drawings and documents alone, i.e., without exchange of technical and engineering personnel.

B. Examples of Industry Methods

1. Western Electric Company

The Western Electric Company purchases over 8,800 parts from suppliers through formal specifications. All purchases are made through the Vice-President for Purchasing and Transportation who has broad authority for purchasing, engineering, inspection and transportation. A group called Purchase Products Engineering is responsible for preparing the specifications, product engineering for a particular item and, in some cases, for both design and manufacturing engineering.

With regard to engineering control, every piece, part, apparatus, component or equipment has a functional engineer somewhere in the system who is responsible for that item. He controls the drawings and it is not possible to introduce a change in this item or a change in the drawings without the control engineer's approval.

, deal- project engr is responsible

Tech data should transfer w/ transition - however this takes people -

By maintaining this sort of engineering control, the company obtains significant benefits:

(a) A high technical competence is obtained not only in the particular product line, but also in the manufacturing processes.

(b) Consultation is encouraged, not only with purchasing but with outside suppliers, thus introducing engineers in addition to specifications into the technology transfer process.

(c) The engineers participate in facility evaluation. Company instructions specify that engineering perform this task before purchasing places an item with a new supplier or places a new item with an old supplier.

(d) The engineers evaluate supply capacity from a given manufacture, tooling costs and manufacturing processes and coordinate their findings with purchasing.

(e) Engineers monitor standardization of items and interfacing of parts when produced by multiple suppliers.

(f) Engineers are alert to other qualified suppliers who might provide additional competitive bidding.

(g) Engineers monitor subcontracting with respect to capacity, ability, and scheduling.

The significant difference in this procedure from that of the Army is the close interaction that Western Electric maintains between purchasing and engineering.

2. Chrysler Corporation

A comparison between the Army TDP and the corresponding documents and systems used in the automotive industry is of interest in analyzing the quality of the Army TDP.

In the automobile industry the product is produced by assembly of components which may either be:

(a) Manufactured in-house.

(b) Purchased from outside manufacturers to whom are transmitted the industry's equivalent of a TDP.

(c) Purchased as a proprietary item specified on the basis of dimensions and performance.

Of these three methods, Items (a) and (b) constitute the major dollar volume and parts volume of the end product. Item (c) is usually confined to components which require a high degree of specialization and know-how, such as carburetors, and low volume components such as AM/FM stereo multiplex radios and tape players, specialized low volume sheetmetal parts and even complete powerplants.

In general, the automotive industry is integrated to a high degree in its ability to design, develop, specify and produce or procure its product. In-house research and development laboratories exist for the design and development of almost every critical component of the vehicle, and production facilities and tools are available for nearly every manufacturing function. Further, product design and development engineers participate in all manufacturing and procurement programs.

In contrast, the Army contracts for much of its research, design and development work and its in-house laboratory capability is generally directed toward those areas which would be unusual to find in industry, would require high capital investment with little opportunity for payout or are directed toward the testing functions which are peculiar to military usage.

Requirements for the industry technical data package differ very little from that used by the Army, whether it is used for in-house manufacturing or for outside procurement. However, it does go through several steps of refinement prior to production which are not always present in the Army system.

If it is assumed that the design and development process is essentially the same in both institutions then the principal differences in the industry system

are in the proof of the TDP prior to its actual use in volume production. In industry a number of samples are made at the same time that pilot tooling information is being transmitted to manufacturers and suppliers. Depending on the product offering and manufacturing volume contemplated, these sample vehicles may range in number from 40 to 300 in any year. The initial use of these vehicles is to refine the TDP and to correct the inevitable errors and omissions which have occurred. These vehicles are then used subsequently for further proving ground testing and development refinement.

About six months before the initiation of volume production 90 to 150 vehicles are built on a pilot assembly line. All components, subassemblies and individual parts for these vehicles are manufactured to and inspected against the TDP requirements and to the extent possible they are manufactured from "hard tools." As these vehicles are produced they are again subjected to proving ground evaluation and test.

The programs described above are, of course, very expensive but they are very much less expensive than attempting to launch high volume production directly from a TDP which is produced directly from an R&D program.

3. Comparison of Army and Chrysler Corporation ECPs

In any Technical Data Package, whether used for in-house manufacturing or for outside procurement and whether used in Army procurement or in industry, an evaluation of TDP quality may be made by an analysis of the number and type of the Engineering Change Proposals (ECPs). In industry engineering changes are approved or disapproved by employing reason codes similar to those given below, plus an analysis of cost and benefits to be derived. A sample industry reason code follows:

Definitions

ALPHA Codes

E - Engineering Requirement
M - Manufacturing Requirement
S - Sales, Product Planning, Styling Requirement

Numeric Codes

1 - TO CORRECT ERRORS
- Engineering Design or Laboratory errors
- Engineering Drafting or Specification Analyst errors
- Tooling Aid errors
- Styling errors in transmitting information to Engineering
- Manufacturing Division(s) Product Engineering errors

2 - TO COMPLETE INFORMATION
- Design completion due to progressive releasing of individual parts prior to completion of a new model program
- Design completion due to authorized release of unfinished drawings to start tooling (including removal of soft pencil notes)
- Add parts omitted on previous Product Change Summary(ies)

3 - MANUFACTURING REQUIREMENTS
- To facilitate tooling and assembly, including changing minor parts to avoid necessity of correcting tooling of major parts
- To allow use of available production equipment
- To revise manufacturing tolerances
- To improve product quality if deficiencies are due to manufacturing conditions
- To allow use of more available materials or parts
- To standardize usage of parts for production plant economies
- To improve repairability
- To bring drawings into agreement with parts as produced or as will be produced from presently existing tooling
- To improve shipping conditions

4 - TO REDUCE COST FROM ORIGINAL PRODUCT PLAN OR TO PREVENT A COST INCREASE

5 - FOR PRODUCT IMPROVEMENT: WHERE PRODUCT MEETS OBJECTIVES CONSIDERED SATISFACTORY AT TIME OF RELEASE
- To improve performance, ridability, or comfort over original plan
- Upgrading of Engineering standards which were considered adequate and acceptable at the time of their release
- Styling changes and changes in model mix over original plan
- Added special equipment
- To meet changes in government regulations

Reason Code - Continued

6 - SERVICE REQUIREMENTS
  - To improve field serviceability or provide for service parts

7 - TO CORRECT PRODUCT DEFICIENCIES OTHER THAN ENGINEERING ERRORS WHERE THE PRODUCT DOES NOT MEET OBJECTIVES CONSIDERED SATISFACTORY AT TIME OF RELEASE
  - Deficiencies resulting from calculated risks in design that are disclosed in prototype-program testing or early production

A comparison between the changes on the five Army example TDPs and the introduction of a new model in the automobile industry is of value. The five Commands responsible for the five Army example TDPs were requested to analyze their engineering change proposals, resulting from the procurement process, in terms of the engineering change reason codes used in industry. For comparison the Committee selected the response of three Commands that furnished ECP reason codes for the following TDPs:

Army Electronic Command (ECOM) - AN/AMP 123
Signal Generator
Picatinny Arsenal - M567 Fuze
Watervliet Arsenal - 105mm M68 Gun

The information furnished by these Commands was compared with the data obtained from Chrysler for a new model launched during 1974. The industrial data cover the manufacture of over 55,000 separate parts of which approximately half were new (previously not manufactured parts) in the 1974 calendar year change cycle. It should be recognized that the change data received from industry included the research and development cycle as well as the changes generated by outside procurement and in-house manufacturing. The comparisons shown in Table 1 are not meant to establish absolute values, but to indicate experience in the preparation of a TDP suitable for obtaining mass-production hardware.

In the case of the M567 fuze, design and development were done under contract to Picatinny Arsenal and a TDP was produced which was subsequently used seven months later for a PPE evaluation program and a first-buy of 300,000

TABLE 1 Percent of Total ECPs by Reason Code

Item	ECP - Reason Codes*							
	1	2	E-3	M-3	4	5	6	7
New Model in Auto Industry	9	14	12	27	7	13.5	7	17
M567 Fuze	12	23	15	61	3	14	0	1
105mm M68 Gun	8	9.5	5.8	26	5.8	41	1.5	7
AN/APM 123 Signal Generator	13.5	0	62	8	0	16	0	0

*Note:

1 - To correct errors
2 - To complete information
E-3 - Manufacturing Requirements from Engineering
M-3 - Manufacturing Requirements from Manufacturing
4 - To reduce cost from original product plan or to prevent a cost increase
5 - For product improvement: where product meets objectives considered satisfactory at time of release
6 - Service requirements
7 - To correct product deficiencies other than engineering errors where the product does not meet objectives considered satisfactory at time of release

units. The refined TDP resulting from this effort was then utilized in a second procurement of one million units.

The 105mm gun was developed in-house at Watervliet Arsenal and the resulting TDP has been used in the procurement of several thousand units with outstanding success.

The AN/AMP 123 signal generator TDP was used for second source procurement so that considerable refinement from earlier TDP and production experience can be assumed.

Of the Reason Codes shown in Table 1 only Reason 1 can be considered to show drawing and specification errors of the Technical Data Package. All three of the Army TDPs were within the range normally to be expected for Reason 1 in industry.

Reason 2 reflects management decisions to meet production timing schedules by releasing preliminary designs of parts in order to initiate tooling before design completion.

Both the E-3 and the M-3 categories reflect changes made to fit a design to a particular manufacturer's plant, machine tools or manufacturing experience. The Committee does not feel that the large percentages shown under E-3 and M-3 for the signal generator and the fuze are reflections on the TDP, but indicate the necessity of ECPs because of the reprocurement from a manufacturer other than the original developer, or a manufacturer whose techniques varied from the original.

Although the data shown in Table 1 are not completely comparable between industry and Army procurement, all of the data from all Reason Codes are included for information purposes. Only Reason Code 1 appears to correlate exactly with Army ECP experience. Reason Code 1 for the industry example shows nine percent for errors and omissions in the TDP. If only the manufacturing launch period and outside procurement changes had been included, this number would drop to two percent.

This comparison of three TDPs created with appropriate discipline shows that they were of comparable quality to those produced in industry. Thus the Committee concludes that the Army is inherently capable of producing high-quality TDPs.

C. Licensing

A licensing technique has been highly successful in aircraft co-production[14] and may be useful in overcoming the problem of technology transfer from the developer to the second producer and in introducing price competition into the procurement of weapon systems and other complex equipment purchased by the DoD.

A "directed licensing" concept[15] would consist essentially of having the government obtain from a weapon system developer, at the time of issuance of the development contract, a commitment for rights to production data and an agreement to license whomever the government designates to produce the weapon system during any or all production, following initial production by the developer. The basic idea of directed licensing is to bring competition to bear after the uncertainties of R&D and early production have been resolved. The developer would agree to provide all available production technology including, but not limited to, drawings and specifications, special tools, jigs, dies, fixtures or other manufacturing aids, operation sheets and machine instruction sheets, machine loading and control data, software for computerized machines, and other data necessary to

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14 G. R. Hall and R. E. Johnson, "Aircraft Co-Production and Procurement Strategy," R-450-PR (Rand Corp., Santa Monica, Calif., 1967) and "Transfer of United States Aerospace Technology to Japan," P-3875 (Rand Corp., Santa Monica, Calif., 1968).

15 R. E. Johnson, "Technology Licensing in Defense Procurement: A Proposal," P-3982 (Rand Corp., Santa Monica, Calif., 1968).

enable the licensee to manufacture the item of equipment developed under the contract. The licensor also would agree to furnish technical assistance required and requested by the licensee. The development contractor would be compensated for his efforts by fees and royalties agreed upon at the time of the initial commitment.

Directed licensing differs in slight but important ways from two related techniques, competitive procurement and leader-company procurement, used by the DoD to introduce competition into the procurement of certain types of equipment. The essential difference between directed licensing and ordinary competitive procurement is the provision in directed licensing for technical assistance from the developer. The difference between directed licensing and leader-company procurement is that directed licensing offers the possibility of no follow-on production for the developer, while leader-company procurement requires that the leader company produce the item in parallel with the second producer, thus requiring a larger total volume of production to make it economically attractive.

To evaluate the feasibility of applying the directed licensing concept to DoD procurements, a recent Rand study included a detailed examination of several related types of activity.[16] Specifically, an evaluation was made of the technology transfer aspects of overseas licensed production of U.S.-designed military aircraft, subcontracting experience between U.S. aircraft manufacturers, and competitive procurement of tactical missiles in the U.S. On the basis of this study, it was concluded that directed licensing is a technically feasible means of introducing price competition into the procurement of complex items of DoD equipment.

Although directed licensing is not a technique for improving TDPs, *per se* it *is* a technique for increasing the efficiency of technology transfer by adding technical liaison to a TDP. Thus, to the extent that the Army's interest

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16 G. A. Carter, "Directed Licensing: An Evaluation of a Proposed Technique for Reducing the Procurement Cost of Aircraft," R-1604-PR (Rand Corp., Santa Monica, Calif., 1974).

in TDP improvement is related to a desire to increase competition in procurement, especially procurement of complex items, directed licensing is a useful technique to consider.

VI

CONCLUSIONS AND ALTERNATIVES

A. Summary of Findings

With present Army policies and practices, Technical Data Package documentation inadequacies are not a major cause of product inadequacies or time overruns. However, because of the volume of Army purchases, the cumulative dollar value of cost increases from TDP inadequacies can be large. In a study[17] of 100 TDPs, Griffiths and Williams state that 78 percent of them resulted in significant savings by competitive procurement but that during production the price increased in 25-50 percent of these to exceed the third, fourth and even the fifth original low bidder, and that 5-10 percent consumed or exceeded the initial savings.

There are standard industrial practices available, many of which have been adopted in whole or in part by the Army, to assure the quality of a TDP prior to its use on a competitive procurement. Such practices, however, are not consistently applied by the Army commands. Consistency could be achieved at a small cost in money, education, or organization, compared to the potential savings in procurement.

The Committee does not suggest that adherence to standard practice will eliminate ECPs. It recognizes that changes for product improvement, if validated by sound cost-benefit analysis, are desirable when they are within the budget of the overall mission requirement. One of the current difficulties is that the Army's

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[17] K. D. Griffiths, and R. F. Williams. "Transmission of Procurement Technical Requirements in the Competitive Reprocurement of Military Design Equipment." PRO-005-1. Army Procurement Research Office, Institute of Logistics Research, Fort Lee, Va., 1971.

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data collection and retrieval system does not adequately distinguish between product improvement ECPs and drawing deficiency ECPs, with the result that critics claim that excessive ECPs arise from carelessness alone. What the Army has not done to protect itself adequately from such accusation is to computerize relevant data for a continuing self-analysis. For example, the ECP reasons could be coded as in Table 1, section VB3, and stored for subsequent analysis.

The reports studied and the specialists interviewed clearly indicate that there has been rapid improvement of configuration management and procurement within the Army. A keen awareness of a sophisticated approach to the problems in the upper levels of procurement management is now evident.[18,19] The committee endorses this approach as well as a strong continuing education of all personnel responsible for TDP development and subsequent procurement.

It also suggests that the Army may wish to explore and experiment with the techniques described in section V and section VIB.

The Committee ascertained that when a procurement contract does run into difficulty through errors, deficiencies, or misunderstandings, in most cases the cause can be attributed to one or more of the following problem areas. Although these areas are not independent, their separation will simplify the identification of the alternative procedures in section VIB.

1. Utilization of Engineers

The single most important impression the Committee obtained is that the Army does not fully utilize its engineering staff in the procurement process.

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[18] "Impact Program Report - Technical Data Package Improvement." Report No. 1. U.S. Army Materiel Command, Washington, D.C., November 1972, 208 pp.

[19] Frederick W. Helwig, K. D. Griffiths, and K. D. Newlin. "Technical Data Package Improvement: Preproduction Evaluation." APRO-204. Army Procurement Research Office, U.S. Army Institute of Logistics Research, Fort Lee, Va., 1975.

In the presentation by Picatinny and Watervliet Arsenals on the fuze and the gun, it was apparent that an adequate number of engineers were constantly in the "loop," advising procurement personnel, qualifying manufacturers, trouble-shooting, etc. In other cases, however, it is evident that engineers do not adequately share responsibility with procurement personnel in the complete development to procurement cycle. In most of the following areas it is implicit that if engineers were more fully utilized, a reduction in problems might be expected.

2. Consistency of TDP Quality

The Army Commands, with independent TDP development and procurement responsibility, have not consistently followed practices which assure high quality TDPs and AMC has not retained a central review organization to assure such consistency.

3. Contractor Qualification

In the course of awarding the contract to the lowest qualified bidder, the bidder's qualifications to produce the item are sometimes not accurately assessed.

4. Buy-Ins and Bail-Outs

At times, a contractor will underbid the actual cost of producing an item, either deliberately or unknowingly. This usually results in claims by the contractor for more money or time when errors occur in the TDP.

5. Motivation of Design Contractor

The developer of a new product under Army contract, if he is also a manufacturer, does not always seem to be motivated to produce the highest quality TDP if he knows that he may have no share in the manufacture of the resulting end item.

6. Proprietary Information

The developer of the new product may use or claim to have used proprietary information in parts of the developed item. These omitted steps or processes in the TDP may place an undue hardship on the winning second source manufacturer, resulting in higher costs to develop his own techniques or in purchase of a part from the developer.

7. TDP Defects

Even in the best cases in which all of the developer's information goes into the TDP there is invariably a certain fraction of drawing errors which, when a manufacturer is dealing with the large number of drawings usually associated with an item, can cause excessive expense and trouble. It should be recognized that if the drawings have not been used for limited production they have not been proven.

8. Technology Which Cannot Be Transferred by Documents Alone

Blueprints and specifications by themselves are sometimes inherently inadequate for a complete technical data transfer between a developer and a subsequent producer. Growing complexity of equipment and multiple choices possible in the manufacturing procedure require close coordination between technical experts at the procuring agency and the contractor if lowest cost and timely production are to be achieved.

9. Cost-Benefit Analysis

Decisions at the AMC or subordinate command level which should be based on available options such as TDP improvement, prototyping, limited production, etc., are not made using the sophisticated cost-benefit analysis techniques commonly available to modern decision making.

B. Alternative Procedures to Current Army Practice

In section V a variety of alternative procedures are self-evident which involve some reorganization of existing Army procurement structure. Since TDP effectiveness is not the only parameter which determines such structure, the benefits must be carefully weighed against the difficulties before adopting such a route, although it should be considered.

Advance Procurement Planning instructions of ASPR clearly state that good candidates for competitive procurement should be selected at an early stage in development. In the course of such selection, the above list of potential problems should be considered. If competitive procurement is the selected route for an item, the following suggested procedures can be used to reduce the anticipated difficulties. The item numbers correspond to the problem areas cited in section VIA above.

1. Utilization of Engineers

In the present organization of the Army, procurement personnel do not themselves have engineering capability and, as mentioned in section IIB, an imaginary rubber band on the TDP is not removed at the procurement stage. This is not the case where hazardous materials are involved, i.e., fuzes, explosives, guns, etc. In these latter cases, engineers are involved in all stages of development through procurement. This procedure is not rigorously pursued in other situations.

An example of industrial practice was given in section VB1 for the Western Electric Co. Each small part has an engineer assigned to it and he has the responsibility for the operation of that part throughout its life cycle. It is the engineer who evaluates manufacturers and sees to it that the part is being made properly and with the most modern methods. Procurement personnel share responsibility with him while serving the company with their competitive procurement expertise.

The people who understand the TDP, the engineers, should be given a stronger role in procurement selection. As in the case of the industrial procurement procedures, engineers should remain in the loop until successful production is assured. Engineers who have prepared and understand the TDP should be a part of the team who evaluate potential production sources. Thus, it will be assured that the selected source has a clear technical understanding of what has to be done and that the selected source is fully cognizant of the TDP requirements.

In the Army examples presented to the Committee where a sufficient number of engineers are constantly in the "loop," the TDP worked with a great deal of success and the Committee strongly suggests that this procedure be considered for all items.

2. Consistency of TDP Quality

A considerable variation in the consistency and quality of TDPs between the five Army TDP examples investigated is evident. While recognizing that pressure to achieve earlier production dates and shorter time schedules for the procurement process sometimes forces risk taking, short cutting the TDP process often can result in increased costs, contractor claims and questionable quality.

The rapid evolution of U.S. Army organizational structure and the diverse management techniques and procedures introduced in the last several years have not resulted in the establishment of consistent and habitual discipline in applying data management procedures. The Army should establish a mechanism to audit, on a regular and frequent basis, compliance to the configuration management regulations on all programs of any reasonable significance. It would be desirable that the audit instrument be independent of the Command responsible for the program. The Committee believes that the establishment of such an audit function would lead to a very prompt and significant improvement in all aspects of Army programs, including TDP management and suitability.

The Army also might give consideration to establishing an independent Army product engineering activity similar to that which is part of the Naval Weapons Engineering Support Activity (see section VA4). Such an activity could be of value in performing audits of TDPs and of configuration management procedures, pre- and post-award, contractor evaluations and surveys, evaluation of claims, disputes, and contractor proposals, functional and physical configuration audits.

Present DoD and Army regulations allow flexibility in determining the resources needed to implement the regulations for a given program. The steps in the implementation generally are the same for all programs, but the resources assigned can be matched to the size and complexity of the program. In especially large and important reprocurement programs, when a Command does not have adequate in-house capabilities, it would be helpful and economical to contract with a qualified engineering firm or with a Federal Contractor Research Center (FCRC) for a complete and comprehensive review of the adequacy of the TDP. In some cases, the engineering firm could be designated as the data manager from that point on, reviewing all proposed changes and correcting the documentation.

3. <u>Contractor Qualification</u>

The Army Commands sometimes have difficulty in rejecting a low bidder that is not considered qualified. Present qualification procedures involve site visits, trip reports and other documentation, all of which are expensive and are done without assurance that the recommendations will be supported fully at a higher level. Although such support is usually available in the procurement of guns or explosives, the other Commands seem to start with the assumption that the burden of proof of nonqualification rests with them. Armed Service Procurement Regulation 1-902 addresses itself particularly to this situation:

> "The award of a contract to a supplier based on lowest evaluated price alone can be false economy if there is a subsequent default, late

> deliveries, or other unsatisfactory performance resulting in additional procurement or administrative costs. While it is important that Government purchases be made at the lowest price, this does not require an award to a supplier solely because he submits the lowest bid or offer. A prospective contractor must demonstrate affirmatively his responsibility, including, when necessary, that of his proposed sub-contractors."

The last sentence clearly indicates that a large part of the proof rests with the contractor.

When the TDP is used for the first time to procure a product, there will inevitably be difficulties in using the data. It is therefore imperative that the Army select a fully qualified contractor for this contract. In the commercial world, companies would achieve this goal by prequalification of the bidders—not letting any company that was not fully qualified bid on the job. However, prequalification in the general sense is not an acceptable procedure in government procurement. The Army must therefore use the available alternatives to assure that the first contractors to use the TDPs are fully qualified. These alternatives are: (a) non-responsibility determinations, (b) experience requirements, and (c) qualified manufacturers. The details of such determination are given in appendix D. Note, however, that procurement officers are not qualified for the technical aspects of such determination and must rely on the engineering staff. This is a clear example of item 1 above that engineering capability is required in the complete procurement process.

4. <u>Buy-Ins and Bail-Outs</u>

At times the low bid will be clearly lower than the cost of producing the item; this is a "buy-in." This is not necessarily deleterious, but it places a considerable amount of uncertainty on the outcome of the contract. The contractor, facing a financial loss, is motivated to contest every government act during performance as well as the adequacy of the TDP itself. Frequently, this results in a significant number of claims which, if paid, are characterized as "bail-outs." DoD Directive 5000.1 clearly calls for downgrading any proposal that carries an unrealistically low price.

When a buy-in is identified through cost analysis the contracting officer has the following choices, depending on the type of procurement:

(a) If the procurement is negotiated, procedures could be adopted which require the contracting officer to fully discuss the low price with the contractor in order to determine the motivation for the low price. During this discussion the contracting officer should fully explain the basis for his judgment that the price is unreasonably low. If, with this information, the contractor opts to withdraw his proposal, he should be allowed to. If he recognizes the cost differential and is willing to absorb it, the contracting officer could require a letter stating this to be placed on file as an indication that the contractor recognizes the buy-in situation. Such a letter would be most helpful to the Army in dealing with claims of increased costs.

(b) If the procurement is advertised, the procedure in ASPR 2-406 relating to mistakes in bids would normally be followed. The contracting officer would ask the contractor to verify his bid price, and in "calling attention to the suspected mistake" would state that cost analysis or other bid prices indicate that his bid is unreasonably low. If the contractor alleges a mistake, the matter should be dealt with according to ASPR 2-406. If the contractor insists that no mistake has been made, the contractor should be ruled nonresponsible because of lack of understanding of the difficulties of production.

5. Motivation of Design Contractor

Most contractors are primarily interested in the manufacturing phase of the life cycle of a weapon system since it is there that they expect to make the major part of their profits. Hence, there is little motivation to create an excellent TDP which will allow the Army to turn the manufacture of the product over to a competitor. The present motivational techniques such as the data warranty clause in ASPR 7-104.9(o) are negative and hence of limited value. The Committee addressed the question of whether there is some possible affirmative motivation which might be used to induce the design contractor to create a better

TDP. It was concluded that the most significant motivation of this nature would be a commitment to the design contractor that he would be given a portion of the manufacturing work as long as he is within a price range, contingent upon his producing a TDP adequate for technology transfer to another manufacturer. Such a commitment would also be of benefit to the Army in that it would:

(a) Maintain engineering know-how of the design contractor until the ability of the second source to manufacture the product is fully proven.

(b) Meet mobilization needs for two or more sources.

(c) Enhance the effectiveness of subsequent competition by ensuring that at least two actively producing manufacturers submit proposals. This is a common practice in commercial procurement.

Even after the technology is successfully transferred, similar benefits can be gained by having two or more competing contractors with the low bidder being given 60 to 70 percent of the work and the balance being given to the other contractor. This also is common industrial procedure and has been used successfully by the Services (see section VA6).

6. Proprietary Information

In accordance with ASPR, section 9, part 2, the developer is entitled to place a proprietary legend on data relating to an item, component, or process developed at private expense. Whenever such items, components, or processes are included in an Army item for which there is a TDP, the TDP must exclude such limited rights data. The means of doing this is to substitute "form, fit or function" data covering that item or component and to leave out the detailed process information. The ASPR policy requires that such form, fit or function data must be furnished without any proprietary legends. However, a TDP containing large amounts of form, fit or function data may not be adequate for use by another manufacturer. Thus, all TDPs must be screened to assure that the designing contractor has not used the proprietary data policy to create an unusable TDP. When the TDP is found to be inadequate for competitive procurement, the Army has four choices:

(a) Purchase the proprietary rights from the developer in accordance with ASPR 9-202.2(f),

(b) Contest the developer's decision that the data is proprietary in accordance with ASPR 9-202.3(d),

(c) Procure the item sole source from the developer, or

(d) Let a separate development contract to design around the item or process, which may indirectly lead to a lowering of the cost.

It is imperative that TDPs be screened in this manner before use on competitive procurements and that the difficulties of inadequate data packages be addressed directly when they are encountered. If the TDP cannot be improved by buying proprietary rights or removal of improperly applied proprietary legends, the TDP should not be used for competitive procurement.

7. TDP Defects

The Army retains some in-house capability for the development of certain types of items. Of the TDPs examined by the Committee, those generated in-house were of high quality. It seems clear that the Army exercises a greater discipline in their in-house development of a TDP than in supervising the efforts of a contractor in the development of a TDP. A crucial part of this discipline in each case of in-house developed TDPs was the proving of the TDP by the construction of one or more prototypes. The Committee suggests that the following procedures be adopted generally to improve the quality of TDPs:

(a) The Committee believes that an evaluation of the TDP by the manufacturer prior to startup is a basically sound concept. However, the introduction of preproduction evaluation (PPE) has resulted in some cases of sloppy TDPs, possibly because of the attitude that the contractor will make the necessary check and corrections during PPE at no cost to the Army. This negligence has caused some complaints by bidders in that this is an additional unknown risk in the cost of PPE. The Army could exercise better control of TDP standards if it

had the centralized review board mentioned in Item 2 which could take a statistical sampling of the drawings in each TDP. This control also could be contracted to a third party review company discussed in section IVA3. The Navy has a validation procedure in which someone is assigned to watch each of the drawings being used by the manufacturer during initial production. This procedure introduces still another step in proving the drawings without the Navy actually building from the drawings itself.

The current PPE procedure has created one significant problem. The present contract clauses do not seem to allocate fairly the risk between the government and the contractor. In exchange for the payment of a specific amount of money, the contractor should be expected to identify and correct normal errors and deficiencies in the TDP which are the result of careless draftsmanship, incomplete review and other defects in the paperwork process. There is no logic to support a policy of holding the contractor financially responsible for design defects in the TDP because he has agreed to review the TDP early in the performance of the contract. If the preproduction evaluation were performed prior to the award of the contract as a separately funded effort, it would be more reasonable to then hold the contractor financially responsible for those design defects that were discoverable through such review. This procedure is not practicable in a competitive procurement situation. Hence, it would seem most feasible to alter the contract clause to clearly state that the Army is responsible for design defects in the drawings but that the contractor has the obligation of promptly notifying the Army of such defects as soon as they are discovered and of minimizing the cost impact of such defects by taking prompt corrective action with regard to such defects. The Navy clause distinguishing between latent and patent defects suggests a possible alternative (see section VA3).

(b) In some cases the Army makes a prototype and tests it, revising the TDP in consonance with the necessary changes. Note that prototype as used here means the final version before production begins. The usual process in contracts is for the item to be developed with non-standard drawings and then the TDP

drawings are made to military standards from the prototype and the working drawings. The "loop" is not closed. The automobile industry, for example, would not consider going into production with such unproven data. Specifications are given to a group which was not involved in the development to see if it can build an accurate model from the drawings. Only by this route can accuracy be assured. Often several models or "Program Cars" are built prior to production and, when changes are made in the documentation additional ones are built. Where the Army has in-house capability prototyping is done, but in most other cases it is not and the "loop" is not closed. The Committee suggests that the Army give serious consideration to proof of all TDPs by prototyping. This can be done by contract to another party, by contract with the developer with the requirement that a different group in the company build from the drawings with no further information exchange, or the Army could consider establishing groups in-house with prototyping capabilities. Limited production runs are also a desirable method of proving TDPs.

8. Technology which Cannot Be Transferred by Documents Alone

It is the experience of industry that technology required for reproduction of complex items cannot be transferred by documents alone. Technology transfer is a major problem encountered by all and is not the Army's problem alone. Differing manufacturing techniques, skills, and experience of workers, etc., preclude the ease of this transfer. When industry subcontracts or enters into contracted co-production, they rely on the exchange of toolmakers, assemblers, engineers, etc., to supplement drawings and other specifications.

In contrast to this experience, the Army system of reprocurement assumes that the TDP is sufficient. The Army's success rate is high, probably because Advance Procurement Planning has rejected competitive procurement for the more difficult items. However, with the cost savings obtainable competitively, there is a continuing desire for this mode of procurement, and difficulties have occured and will occur as modern items become more complex and attempts are made to transfer technology on these items by using TDPs alone.

There is no easy solution for technology transfer in this situation under existing laws which relate to government contracts. The Committee suggests that the following three approaches be tried and experiences be exchanged within the Services:

a. Directed Licensing

The concept of Directed Licensing was discussed in section VC, and its possible applicability in Army procurement is summarized here.

Directed Licensing is a concept for introducing price competition into the reprocurement of items that are too complex to transfer to a second producer by more conventional means, i.e., by a TDP alone.

The essential difference between Directed Licensing and ordinary competitive procurement is the provision in Directed Licensing for technical liaison between the developer and the follow-on producer. The Directed Licensing concept also provides for transfer of tooling to the follow-on producer and for payments by the follow-on producer to the developer for the developer's efforts in preparing the TDP, providing tooling and technical liaison and maintaining design responsibility. The fee for maintaining design responsibility is in the form of a royalty (i.e., it is tied to the number produced by the follow-on producer) to provide an incentive for the developer to assure adequate transfer of the technology and to continue to improve the product.

The Directed Licensing concept avoids overly complex documentation in that directed licensing proposes to use relatively simple TDPs supplemented as required by technical liaison. It also provides for the building of prototypes before production, independent party review of the TDP (the follow-on producer), continuing responsibility for up-dating the TDP and for engineering improvements, technical assistance and training as well as computer programs for machines. It would also require a follow-on producer to bid lower than the developer by at least the percentage of royalty and service fees in order to win the contract, more fully explained in references 13 and 15. A potential drawback is that a royalty paid for technical data developed under government contract may

not be legally allowable. It might be permitted, however, to pay a fee proportional to the effort involved in transferring the technology and for the continuing effort of the developer in maintaining the TDP, quality control and continuing improvement. Two possible modifications of this approach are given below.

b. Leader Company Procurement

In Item 5 above, a technique was discussed for use when the Army can justify a need for two or more sources. In such cases, a Leader Company can be paid a fee to teach a second contractor to produce the item, transferring the necessary technology in the course of this effort. This fee technique could also be used to maintain the continuity of production, in cases where there is only one manufacturer at a time, by keeping the first contractor in production while the follow-on contractor is in the startup phase. In such cases, the technique would be difficult to implement because the first contractor would not be motivated to fully transfer his know-how knowing that the Army intended to use only one source over the long term. This problem can be alieviated by retaining the designer as a manufacturer, as discussed in section VIB5.

c. Learning Contract

A developer might find a requirement objectionable that he teach a competitor with his own personnel or allow representatives from the competitor into his plant. In this case, a learning contract, assuring a portion of the manufacturing, as discussed in section VIB5, could be made to teach government engineers the more complex technology in the developer's plant. These engineers then would be able to supplement the TDP by personal visits to the second source, and thereby assist in transferring the technology. Note that in this situation if the Army tells a manufacturer how to do something, the Army must accept responsibility if something goes wrong. However, such transfer of technology is normal practice in industry. These and other possible uses of Leader Company procurement as a means of transferring technology could be explored as methods of supplementing the TDP as the sole means of transfer.

9. Cost-Benefit Analysis

Procedures such as prototyping, limited volume production, the collection and analysis of reliability data, more careful reviews of TDPs, etc., have a cost. The choice of these options can be determined by cost-benefit analysis. While industries have such analysis groups available to them, it was learned that AMC and the subordinate commands do not.

The Committee suggests that a cost-benefit analysis capability for the selection of the optimum procurement strategy be made available to the Commands either within the Army or by contract. One example of the use of such analysis in industry is found in the adoption of systems for more complete "loop-closing" on the TDP. In complex systems TDPs are not released until they have been checked and corrected against a sample product built from the original TDP. The corrected TDP is then used to build limited volume production before high volume production is initiated. Cost-benefit analysis indicates the benefits for various limited volumes.

A cost-benefit analysis by the Army of the entire history of current procurement might be made to determine the degree to which this practice should be followed in military procurement. It is believed that these cost analyses will show the necessity for more extensive loop-closing on the TDP in the Army system.

C. Concluding Remarks

It is the considered opinion of the Committee that the Army TDPs, when employed with discipline, are effective means of technology transfer in situations where documents alone are sufficient. The effectiveness of the TDP in procurement can be enhanced by a closer coupling of engineering and procurement functions and, further, the TDP must be reinforced by direct participation of knowledgeable engineers for technology transfer when complex items are involved. To maximize its effectiveness, the TDP should be of high quality and contain the

essential data commensurate with the complexity of the item. Therefore, the success of technology transfer can be enhanced through the exercise of greater care in producing and proving, by prototyping and limited production runs, highly accurate TDPs prior to major procurements. The Committee learned that Engineering Change Proposals and contractor claims associated with TDPs account for significant sums of money in the procurement process, although the proportion directly attributed to faulty TDPs was not ascertained. As a result, the thrust of the suggestions has been to offer possible procedural changes which, when employed selectively will, in the view of the Committee, improve the effectiveness of the TDP in the technology transfer process.

VII

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APPENDIX A

Presenters in the Orientation Briefing

January 7 - 10, 1975

(Listed in the order of presentation)

G. A. Kanzaki, AMETA
Rock Island Arsenal
Introduction to the Technical Data Package

H. Lowers
Army Missile Command
General Overview of Effectiveness of Technical Data Package

B. Stutsky
Army Materiel Command
Procurement Procedures and Policy

K. Griffiths
Army Materiel Command
Survey of 100 Technical Data Packages and Their Effectiveness

K. Griffiths
Army Materiel Command
Preproduction Evaluation as a Tool in Contracting

S. J. Lorber
Army Materiel Command
Quality Assurance in the Technical Data Package

R. F. McDermott
Small Business Administration
Small Business Participation in Military Procurement

D. B. Kececioglu
University of Arizona
Reliability Engineering Concepts

A. C. Marotta
Army Electronics Command
Transponder Test Set

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J. C. Heavey, TROSCOM
Army Troup Support Command
Ribbon Bridge (Transporter and Floating Bridge)

F. Rutkovsky and A. Nash
Picatinny Arsenal
Fuze

L. Womack
Army Missile Command
Second Stage Rocket Motor Case

F. Schneider and A. Albright
Watervliet Arsenal
Gun, 105mm M68

Col. J. Van Cleve
U. S. Army, Legal Services Agency
Contractor Appeals and Suits

J. B. Toomey
Value Engineering Co.
Effectiveness of Third Party Review

E. D. Ross
Naval Air Systems Command
U. S. Navy Procurement Methods

H. S. Wahlberg
Western Electric Co.
Industry Procurement Methods

W. J. Cronin
The Budd Company
Industry Procurement Methods

G. A. Carter
Rand Corp.
Aircraft Industry Co-production and the Concept of Directed Licensing

D. L. Hersh
Office of Counsel
Naval Air Systems Command
Legal Constraints

R. C. Nash, Jr.
George Washington University
Legal Constraints

APPENDIX B

Product Assurance Aspects of Technical Data Package Improvement

Product Assurance[20-24] is defined as design and control techniques that assure that a product, be it a component in an ammunition fuze or a complete system like a ribbon bridge, will be so designed, built, delivered, and used that its designed-to function will be performed without failure and successfully for a desired use-time, at a specified confidence level, while it is functioning under prescribed application and operation stress levels. For a TDP to accomplish its objectives product assurance should be involved in all aspects of the development of the item. When the TDP is reviewed internally, before being used for procurement, documents and check lists relating to product assurance should be attached. When the TDP is made part of the procurement package only quality assurance requirements are included. For the internal review a list of applicable product assurance military or NASA standards and specifications should be provided. These specifications should explicitly define the following:

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1. Reliability requirements.
2. Maintainability requirements.
3. Availability requirements.
4. Safety requirements.
5. Quality requirements.

Improvement of the developed item from these five aspects may be accomplished as follows:

1. <u>Reliability Requirements</u>

The reliability should be quantitatively prescribed, as well as the mission duration, or operating time, any allowable down times during the mission with their duration, the application stress levels and their complete profile, the operation stress levels and their complete profile, the numerical confidence level desired, and any age implications.

2. <u>Maintainability Requirements</u>

Appropriate maintainability clauses include the determination of the times to restore the equipment were it to fail, the probability of completing the restoration actions within a desired period of time, the mean or median time to restore the over-all equipment, the required maintainability demonstration tests with their associated producer's and consumer's risks, and the maintenance policy to be pursued.

3. <u>Availability Requirements</u>

Availability is defined as the probability, at given confidence level, that the equipment will be available for operation within a prescribed period of time without down-time for maintenance.

4. <u>Safety Requirements</u>

Safety is defined as the probability that the equipment, were it to fail, will not cause injury or death to the operator and personnel in the vicinity of

the equipment, and will not cause damage to property in the vicinity of the equipment or to the equipment itself.

5. Quality Requirements

Although quality requirements have been widely pursued over a long period, specific details of quality requirements do not appear to be included in all TDPs.

APPENDIX C

The Navy Patent and Latent Defect Clause

The Navy has been using a clause in its contracts similar in principle to the Army Preproduction Evaluation Clause. This clause is included in this Appendix although it is a precursor to the clause which will appear in the Navy Regulations. In other words, the present one is not in final form and should not be used or quoted as such.

The clause would have different wording in different kinds of contracts. In order to explain its use, variations and background, the Navy circulated a trial explanatory form to its procurement personnel. Again, this is not in a final version and is not to be quoted as such. However, the Committee feels that the presentation is highly informative and is a necessary addendum to the clause itself. With the Navy's kind permission we include the instructions and the precursor to the clause verbatim below.

INSTRUCTION SHEET

BACKGROUND

1. For years, the Navy has experimented with exculpatory or "disclaimer" clauses in technical data situations. They are devices whereby the Government, in providing a technical data package to a production contractor, says "Use it for what it's worth --we don't promise that following it will enable you to perform your contract." It owes its existence to two persistent phenomena: (1) the traditionally imperfect state of Government technical data packages, and (2) the recurring judicial conclusion that in furnishing such data the Government impliedly warrants its adequacy to do the required job. The Government's natural reaction has been to disown defective technical data it provides a contractor by using an exculpatory clause, attempting, thereby, to shift the financial risk of the deficiencies to the contractor.

2. When the Government furnishes a technical data package without exculpatory language, it usually does so under the Government Furnished Property clause. As a result, the Government

(a) warrants the sufficiency of the data to meet the performance requirements;

(b) takes advantage of the development and engineering that have already gone into the technical data package;

(c) eliminates the need or the opportunity for the contractor to re-engineer the entire job;

(d) retains the desired degree of design control, standardization, or interchangeability; and

(e) compensates for data package errors, omissions, and deficiencies in accordance with Changes clause procedures.

The contractor, on his part, can submit his price proposal free from contingencies because he can rely upon following the technical data package and upon receiving an appropriate equitable adjustment where it is defective.

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3. If, on the other hand, a technical data package is furnished with exculpatory language, the contractor is being told, in effect, that he must assume the risk of absorbing whatever it may cost for engineering and any other effort necessary to meet the performance requirements of the contract because following the data package will not necessarily do the job. Since the exculpatory clause--assuming it will withstand the challenge of litigation--deprives him of any means for later compensation under the GFP clause, and since its very appearance in a contract is a red flag warning of data for which the Government wants no responsibility whatsoever, the contractor's only alternative is to include a sufficient contingency in his price to cushion the worst data package he can anticipate.

4. Since he cannot rely upon the technical data package to perform the contract, therefore, he must be prepared to perform whatever engineering--possibly even research and development--becomes necessary to produce specification equipment. This obviously restricts competition to firms large enough to undertake this considerable risk, and even the largest companies have shown little inclination to eat a sizable loss when it actually occurs. The results have ranged from changes claims and litigation--despite the exculpatory clause--to threats to halt production until compensation is somehow provided. And in every case it has meant a substantial loss in time.

5. So, the upshot of an exculpatory clause can be
- (a) questionable pricing due to the contingency included for the disclaimed technical data package,
- (b) loss of control over design, standardization, or interchangeability,
- (c) need for the contractor to launch his own development and engineering program,
- (d) claims for adjustment in price notwithstanding the existence of the clause, and
- (e) loss of time and delays in delivery.

For these reasons, the exculpatory clause is often more a liability than an asset, and generally inferior to more straightforward and businesslike approaches such as those described below.

CORRECTION OF PATENT AND LATENT DEFECTS CLAUSE

6. Enclosure (1) is intended for use in lieu of exculpatory or "disclaimer" clauses principally in initial competitive procurements, or initial noncompetitive procurements of equipment developed in-house and only produced previously in Government plants, where the accuracy of the technical data package to be furnished to the contractor has not been and cannot be firmly established in advance of contracting. It is also authorized for use in any other procurements where deemed appropriate. The concept of this clause is essentially opposite that of an exculpatory clause, for here the Government in effect guarantees the technical data package it furnishes to the contractor.

7. Under the procedures of Enclosure (1), an appropriate clause in the schedule of the solicitation should
- (a) advise prospective offerors where and when the technical data package will be made available for review and examination;
- (b) warn them, because of their contractual liabilities (see (d) below), to make such review and examination for the purpose of determining (i) the apparent or "patent" defects the engineering drawings contain, and(ii) the cost and time to correct all apparent or "patent" defects;
- (c) advise them to include in their proposed price and delivery terms their estimates of cost and time to correct all apparent or "patent" defects;
- (d) refer to the CORRECTION OF PATENT AND LATENT DEFECTS clause and
  (i) emphasize the contractor's responsibility thereunder to correct all apparent or "patent" defects--whether or not he reviewed and examined the technical data package and whether or not during that review and examination he discovered all apparent or "patent" defects, and
  (ii) advise also that under this clause "latent" defects would be handled in accordance with this clause and, where corrections are ordered, the Changes clause.

8. It is recognized that differing procurements may require varying uses of detailed specifications, referenced specifications, performance specifications, interchangeability requirements, and Government-furnished models. Enclosure (1) is intended for use in cases where the contractor is required to perform in accordance with the engineering drawings except to the extent they are incompatible with the performance specifications, in which case the performance specifications govern. Even in cases where no exculpatory clause is being considered because performance is to engineering drawings alone (there being no performance specifications involved), this approach is still recommended for the purpose of establishing a better method and control of correcting and pricing drawing errors; in such cases, the contracting officer is authorized to make any necessary revisions to Enclosure (1). Variations in terminology used in particular Commands, such as "design disclosure," "procurement data package," etc., may also be incorporated in the clauses as appropriate, provided that the purpose of the clauses is not affected thereby.

9. If a model of the equipment is furnished to the contractor by the Government, the contractor should be obligated to refer to the model only when he is correcting defects, and then only to meet the

level of interchangeability set forth in the contract. In those instances, the contractor's responsibility should be to make such corrections that the parts or components as revised will be interchangeable with the model, unless, in the case of "latent" defects, he is directed otherwise by the contracting officer. To be consistent with the purpose of these clauses, the model should be "exculpated" for all purposes other than interchangeability.

10. Contracting officers should consider the advisability of holding a bidders' conference to
(a) assure complete understanding of the purpose, procedures, and responsibilities of this approach;
(b) advise of particular errors, mistakes, defects, etc., if any, of which the Government has knowledge; and/or
(c) inform all offerors that the Government is willing to predetermine with the successful offerors which categories of errors, mistakes, and defects shall be considered "patent" or "latent".

Contracting officers may then predetermine with the successful offeror that particular types or categories of errors, mistakes, defects, etc., shall be deemed "patent" or "latent" as the case may be; in that case, such agreement shall be reduced to writing and included in the contract schedule. If the successful offeror has previously produced specification equipment, all defects should ordinarily be predetermined to be "patent defects," since such prior producer should be aware of all deficiencies at the outset.

11. The contracting officer should also ensure that the Navy receives such technical data constituting the corrections or changes to the Government-furnished technical data package by calling specifically therefor on DD Form 1423 in order to acquire unlimited rights as provided in ASPR 9-202.2(b)(3).

12. The success of this procedure will depend in part upon the Navy's own appraisal of the engineering drawings. Unless those drawings were subjected to in-process verification and review during their preparation, they should receive, prior to being used in the circumstances described above, an ad hoc inspection by qualified personnel, such as by the Naval Weapons Quality Assurance Office (QAO). Such a review would provide specific knowledge of their quality and condition and, based upon that knowledge, opportunity for making the most intelligent decision on how to use them. And as applied to the approach suggested here, it should enable the Navy to ensure obtaining a reasonable price for the correction of all apparent errors in the package, as well as to assist in making any predetermination of defects.

INCOMPATIBILITIES BETWEEN PERFORMANCE SPECIFICATIONS AND ENGINEERING DRAWINGS

13. Whereas the purpose of Enclosure (1) obligates a contractor to expose "patent" defects in a timely manner and to report "latent" defects as they arise, Enclosure (2) obligates the contractor to expend a specific engineering effort to search out and uncover--early in contract performance--those "latent" defects that represent incompatibilities between engineering drawings and the mandatory performance requirements. Such would be the case where previously delivered equipment complied with the engineering drawings, but incompatibilities still exist because the equipment that was accepted did not meet one or more mandatory performance requirements. Thus under Enclosure (2) a contractor would be obligated to undertake an effort to search out and expose the specific engineering drawings containing these incompatibilities other than "apparent" errors at an early enough time to permit necessary redesign to assure the equipment will meet mandatory performance requirements, without having to scrap or rework substantial quantities of hardware already produced under the contract. Where Enclosure (2) is not used, it is possible that so much hardware may have been produced before the incompatibilities are discovered that the expense and time involved in effecting necessary redesign may make it uneconomic or untimely.

14. Under Enclosure (2), therefore, the Government is to be notified of incompatibilities and will be able to determine, on the basis of applicable trade-offs, whether its interest is better served by
(a) relaxing a mandatory performance requirement so that it matches the equipment and drawing, or
(b) upgrading the equipment and drawing so that they meet a mandatory performance requirement.

In addition, an appropriate clause in the schedule of the solicitation would advise prospective offerors of
(a) The line item setting forth the contractor's obligation to expend engineering efforts to expose all instances where equipment produced in compliance with the engineering drawings will not meet the mandatory performance requirements of the specification, with a space for the offeror to insert the price he wants therefor, and
(b) the procedures provided in the clause for handling such cases.

When Enclosure (2) is used, those performance requirements of the performance specification that are selected to be mandatory must be so specified in the solicitation and in the resulting contract.

15. Accordingly, when the Government knows that the version of the equipment depicted by the engineering drawings failed to meet the performance specification, but was accepted anyway, Enclosure (2) should be seriously considered for use in future procurements of that particular equipment. If the Government concludes that the engineering drawings have "patent defects," but that even after correcting them equipment made in compliance with the engineering drawings will still not meet the performance specification, the use of Enclosures (1) and (2) together is warranted. If the Government concludes that the engineering drawings have been purged of "patent defects" during previous production runs, but nevertheless equipment made in compliance with the engineering drawings will not meet the performance specification (just as equipment under the earlier production runs did not meet it), the use of Enclosure (2) alone is warranted. If the Government concludes that the engineering drawings have "patent defects," and that after they are corrected equipment made in compliance with the corrected drawings will meet performance specifications, the use of Enclosure (1) by itself is warranted (see paragraph 8).

CORRECTION OF PATENT AND LATENT DEFECTS

1. The technical data package consists of
   (a) the performance specification designated in the schedule, and
   (b) the engineering drawings designated in the schedule.

2. For the purpose of contract performance, it is to be considered that equipment manufactured or assembled in accordance with the engineering drawings will meet the requirements of the equipment specification. Therefore, the Contractor is required to perform in accordance with the engineering drawings except that in case of conflict between the engineering drawings and the equipment specification the latter shall govern. Accordingly, the Contractor is obligated, as an element of contract performance, to find and expose all patent defects in the engineering drawings, to correct such defects, and to manufacture or assemble equipment in accordance with the engineering drawings as revised and corrected hereunder. Furthermore, whether or not he conducted an inspection of the documentation package as he was urged to do in the solicitation for this contract, and whether or not he discovered the patent defect if he did conduct such an inspection, the Contractor shall not be entitled to any compensation over and above the price set forth in the schedule or any extension in the delivery dates therefor because of the accomplishment of these obligations with respect to patent defects.

3. (a) The engineering drawings, which term includes the documents referenced thereon, are furnished to the Contractor under this clause and no other; however, the engineering drawings are "Government-furnished data" within the meaning of that term as used in paragraph (b)(1)(iii) of the "Rights in Technical Data" clause hereof.

(b) A "patent defect," as used in this clause, is any failure (by omission or commission) of an engineering drawing, or document referenced thereon, to depict completely and accurately the equipment described in the performance specification, which failure could or should be found by a reasonable, diligent inspection of the technical data package by competent engineers or technicians experienced in the field of which the equipment is a part.

(c) A "latent defect," as used in this clause, is any failure (by omission or commission) of an engineering drawing, or document referenced thereon, to depict completely and accurately the equipment described in the performance specification which is not a "patent defect."

4. (a) The Contractor shall notify the Contracting Officer in writing of each latent defect. Such notification, which shall be given within five days of the discovery of the defect by the Contractor, shall describe the defect and its effect on the balance of the equipment, identify both the particular engineering drawing(s) and the portion(s) of the equipment involved, and explain why the defect is not patent. The Contractor shall supply such additional information supporting the notification as the Contracting Officer may require.

(b) Upon receipt of such notification, the Contracting Officer may direct the Contractor
   (i) to continue performance with respect to the asserted latent defect in accordance with the engineering drawings;
   (ii) on the basis of the Contracting Officer's determination that the defect is patent and not latent, to revise and correct the defect in the engineering drawing and to perform in accordance with the Contractor's obligations with respect to patent defects;
   (iii) to suspend, delay, or interrupt work, pursuant to the "Suspension of Work" clause, with respect to the portion(s) of the equipment involved in the asserted latent defect; and/or
   (iv) to submit a proposal for correcting such latent defect.

(c) With respect to (iv) above, each proposed correction shall be submitted to the Contracting Officer within a reasonable time and in accordance with Engineering Change Procedures set forth elsewhere herein. Thereafter, the Contracting Officer shall issue a change order to the engineering drawings and/or to the performance specification in respect of the latent defect and such equitable adjustment shall be made in the line item price for the equipment and/or in the delivery schedule therefor as is appropriate under the Changes clause.

5. If the clause entitled "Incompatibilities Between Mandatory Performance Requirements and Engineering Drawings" is included in this contract, the procedures set forth in such clause shall apply to all "latent defects" which pertain to mandatory performance requirements.

6. The Disputes clause of this contract shall apply to disputed questions of fact arising under this clause.

INCOMPATIBILITIES BETWEEN MANDATORY PERFORMANCE REQUIREMENTS AND ENGINEERING DRAWINGS

1. The rights and obligations of the parties set forth in this clause are in addition to those set forth in the clause, if any, entitled "Correction of Patent and Latent Defects."

2. The mandatory performance requirements applicable to this contract are those particular requirements of the equipment specification which are identified and designated as mandatory in the schedule.

3. With respect to these mandatory performance requirements, the Contractor shall conduct such engineering effort as necessary to expose any and all instances where a part, subassembly, component, assembly, group, or the equipment itself when manufactured or assembled in compliance with the engineering drawings will not meet a mandatory performance requirement. This engineering effort shall be so formulated (including requisite analysis, surveillance, evaluation, inspection, and test) and administered as to expose such instances, if any, at the earliest feasible time.

4. The Contractor shall notify the Contracting Officer of each instance where the equipment or any portion thereof when manufactured or assembled in compliance with the engineering drawings fails or will fail to meet one or more mandatory performance requirements. Such notification, which shall be given within five days of the discovery of the failure by the Contractor, shall identify the portion or portions of the equipment and the particular mandatory performance requirement(s) involved and shall set forth sufficient information to substantiate the failure. The Contractor shall furnish additional substantiating information if requested by the Contracting Officer.

5. The line item price set forth in the schedule for the equipment to be delivered under this contract does not include any amount for performance of the Contractor's obligations under the clause entitled "Incompatibilities Between Mandatory Performance Requirements and Engineering Drawings": rather, the price set forth in the schedule for item ____ is the amount the Contractor is entitled to for performance of his obligations under the two preceding paragraphs.

6. Upon receipt of such notification, the Contracting Officer may direct the Contractor

(a) to continue performance with respect to the asserted failure in accordance with the engineering drawings;

(b) to suspend, delay, or interrupt work, pursuant to the Suspension of Work clause, with respect to the portion or portions of the equipment involved in the asserted failure; and/or

(c) to submit a proposal for correcting such failure.

7. With respect to Paragrpah 6(c) above, each proposed correction shall be submitted to the Contracting Officer within a reasonable time and in accordance with Engineering Change Procedures and setting forth a reference to the previous notification, the reason for the asserted failure, the proposed correction, and a proposed price (including a cost breakdown) for effecting such correction. Thereupon, the Contracting Officer shall either

(a) direct the Contractor to continue or resume performance with respect to the asserted failure in accordance with the engineering drawings, in which event the Contractor shall not be entitled to any extra compensation or any extension in delivery dates except to the extent that he may be entitled to such adjustments under the Suspension of Work clause, or

(b) issue a change order with respect to the asserted failure in which event such equitable adjustment shall be made in the line item price for the hardware and/or in the delivery schedule therefor as is appropriate under the Changes clause.

8. The Disputes clause of this contract shall apply to disputed questions of fact arising under this clause.

APPENDIX D

Contractor Qualification

(Supplement to Section VIB3)

A. Non-responsibility determinations.

Each contracting officer has the obligation of determining that award is made to a contractor that is determined to be responsible--to have the necessary management and technical skills, equipment, financial ability, integrity and perseverance to perform the work. In meeting this obligation in procurement with TDPs, it is imperative that there be a thorough evaluation of the technical capabilities of the prospective contractor such as the ability to produce from a TDP which he did not generate and the ability to meet stringent product assurance requirements. It should be noted that the prospective contractor's will to do the work is included as well as his ability to perform. The contracting officer has broad discretion to determine a bidder non-responsible but clearly the record should be documented to avoid any implication that the decision has been made arbitrarily. It is therefore advisable that past performance of contractors be documented to show difficulties that have been encountered in the initial manufacturing of new products. Cases of excessive claims and dilatory tactics in contract administration are grounds for determining that a bidder is non-responsible on the grounds of lack of perseverance, 43 Comp. Gen. 257 (1963). Again, careful documentation is necessary to demonstrate that the contracting officer is acting reasonably. If these procedures are followed, the Army can avoid the award of initial manufacturing contracts to marginal companies.

It can be expected that a declaration of non-responsibility will be followed by a protest to the Comptroller General. Such protest will block the award of the contract in accordance with ASPR 2-407.8(b) until the Army exercises

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one of two options. It can either (1) certify that the procurement is urgent and make the award or (2) process the protest to conclusion before the Comptroller General. In the latter case, a delay of from 60 to 150 days can be anticipated (assuming the Army acts promptly in contesting the protest). Determinations of non-responsibility should not be made unless the command elements of the Army are firmly committed to backing the contracting officer in any ensuing protest and proceeding to award in those procurements which are urgent. Hence, any policy adopted to make more complete use of the right of the government to declare bidders non-responsible should be fully coordinated with these command levels before it is adopted.

B. Experience requirements.

As an adjunct to the determination of responsibility, contracting agencies may include in their information for bidders special experience or technical requirements which will be used to judge minimum levels of responsibility. ASPR 1-903.3 permits this technique but gives little guidance on its use. Army Document PRO-005-1, Transmission of Procurement Technical Requirements in the Competitive Reprocurement of Military Design Equipment, June 1971, suggests that such requirements are applicable to almost all initial manufacturing contracts to TDPs (pp. 133-34). The value of this technique is that it informs prospective bidders of the fact that they will not be eligible for award unless they meet the requirements and thus warns them not to incur the costs of preparing a bid if they do not meet the requirements. The special requirements could be stated in the form of past experience e.g., 45 Comp. Gen. 4 (1965), special equipment, the ability to use special processes, or other requirements which are vital to the successful manufacture of the item.

C. Qualified manufacturers.

The Comptroller General has approved the use of Qualified Manufacturers Lists in certain selected areas, Comp. Gen. Dec. B-135504, May 2,

1958, Unpublished (clothing manufacturers); 50 Comp. Gen. 542 (1971) (microcircuitry for NASA). The key to this approval is apparently a finding by the procuring agency that the prescreening of bidders is vital to meet the needs of the agency and a complete statement of the procedures to be followed (to avoid unfairness to industry). See 53 Comp. Gen. 209 (1973). While it is not believed that this technique could be widely used by the Army without substantial criticism, it is usable in selected procurements where the highly technical nature of the product indicates the desirability of limiting the bidders to pre-screened companies.

A justification for this procedure might be found by redefining the TDP as documents which are expected to change to reflect product changes for design improvement, speed of production, etc., which generally result during production by a qualified manufacturer. That this is indeed the case has been amply demonstrated by the evolution of a large number of military items.

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